THE

ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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	Page
Patents and Prejudice	561
Current Transformers for Instruments (*illus.*)	563
Trade Statistics of the Transvaal	565
Three-Phase Transmission at 25,000 Volts	565
The Industrial Power Problem	565
Legal	567
Correspondence	568
Electricity Supply in Birmingham (*illus.*)	571
The Engineering and Machinery Exhibition at Olympia (*illus.*) (*concluded*)	574
Business Notes	575
Electricity in Steel Works (*illus.*)	579
City Notes	588
Electric Tramway and Railway Traffic Returns	590
Stocks and Shares	590
Share List of Electrical Companies	591
Notes on the Working of Water-tube Boilers	593
Some Recent Electrical Cases	594
Our University Laboratories: A Defence	595
Some Considerations on the Double-Flow Turbine	596
Reviews	597
Electricity and Mining Operations	599
New Patents Applied For	600
Published Specifications	600

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PATENTS AND PREJUDICE.

"ONE of the root causes of our comparative manufacturing decline" is "the granting of Patent monopolies in Great Britain to non-resident foreigners." This is because of its bearing "upon industrial development, and upon opportunities of employment at home." So says Sir Joseph Lawrence in an article in the October number of the *National Review* entitled, "British Patent Laws and their Relation to Industrial Employment." The remedy which Sir Joseph seeks strenuously to enforce is "the assimilation of British Patent Law, so far as regards compulsory working, to that in force in the larger European countries," and he proposes, in accordance with a resolution of the Associated Chambers of Commerce, that the Patent Laws be amended so as to "enforce in the United Kingdom the forfeiture of all British Patents for inventions which are worked without but not within the United Kingdom, after the lapse of three years from the date of application in the country of origin, unless the patentee can justify his inaction to the satisfaction of the Board of Trade." A deputation waited upon the President of the Board of Trade on April 9th last to urge this view, and a smaller deputation on points of detail is to attend on the 18th inst.

The question is one of much importance, and needs careful consideration. The influence of changing conditions, whether of manufactures or otherwise, ought certainly to be reflected in our laws, and we hope there are but few who would maintain that a policy adapted to the times of James I is equally applicable to the times of Edward VII. But there are certain broad principles which are not affected by time. One of these is a recognition of the rights of a creator. A writer in the *Quarterly Review* of 1859 says: "The propriety of granting patents, if questioned at all, must be questioned on the ground of expediency, not of justice. No one can deny that the man who produces anything is entitled to a property of some kind in the product. If the crude material be abstracted from what may be considered the common possession of mankind, as a pebble from the seashore, the labour of the lapidary gives him a special title to the polished article. It is, therefore, impossible to contend that when a man, by the mere exercise of his intellect, taking nothing from, but on the contrary adding to, the common stock, compiles a book or contrives an invention, he is to have no property in what is just as much a product of his brains, as the polished pebble is of the lapidary's hands. Common honesty demands that he should be allowed to derive some benefit from his own work, and the extent of his interest is determined in this country by our system of copy and patent right. But while the justice and expediency of a copyright in literature are recognised, prejudices still exist against patents, as if they were a remnant of the old abuse of monopolies by which an individual obtained from the crown the right to the exclusive exercise of some particular trade."

Another broad principle unaffected by time is that the grant of a patent, whilst an act of justice to an inventor, is also subject to the expediency of the State. What is expedient for the State is likely to be the subject of diverse opinions, according to the point of view of individuals or the interests of communities. But the principle of "common honesty" which has been quoted in connection with the grant of a patent needs also to be considered in connection with the conditions proposed for forfeiture of a patent. It, therefore, becomes desirable to consider such proposed legislation from a wider platform than is represented by the interests of any one section of the community, and also to examine carefully all arguments that may be urged by advocates of change. The wider question we must leave for a subsequent occasion, and to-day deal only with some of the figures and arguments in Sir Joseph's article which relate to one department of the electrical industry.

"A glance at one single industry," he says, "will give some idea of the havoc wrought in the ranks of skilled labour by the absence of a compulsory working Patent Law. I allude to the telephone industry." The company owning the patents "never attempted to make a single telephone in this country, though they granted a limited licence to a small concern, which ultimately failed, and not 1 per cent. of the telephone material used by the United Telephone Co. was ever made in London."

It is conceivable that an advocate may have used arguments more damaging to his cause, but, if so, it has not come under our notice. The "limited licence" granted to the "small concern" was a licence by the patentees to manufacture their total requirements for the supply of the only apparatus for which they held any patents. If, therefore, only 1 per cent. of the material were manufactured in London, it must have been because 99 per cent. of their requirements lay outside the scope of their patents. What is the application of the instance recited to the demand for compulsory manufacture, when it is shown that such manufacture was undertaken without any such compulsion? And is it to encourage the others that we are informed the manufacturer ultimately failed?

"The amount paid to foreign companies prior to the lapse of the patents in 1890, for apparatus which ought to, and could easily, have been made in this country, is computed at £10,000,000 at least."

Sir Joseph, we are sure, will recognise the importance of accuracy in statements put forward with a view to influencing changes in the law. As a legislator himself, he would be the first to condemn any attempt to mislead, and would insist upon accuracy — reasonable accuracy we mean, of course; there is no need to go to five places of decimals. When he says that an amount is computed, and does not say by whom it is computed, the figures attain the additional importance of being fathered by himself. We wonder whether his reliance on information imparted to him is general, or whether he has attempted to check it in any way. We wonder, for example, whether it occurred to him to ascertain the expenditure of the Telephone Co. up to 1890. If he will refer to our files for that year he will find that the issued capital of the National Telephone Co. was, at that date, under £2,500,000.

In the next calculation given by Sir Joseph, he gives also his authority. It covers a wider period, and has necessarily more imposing figures. "Since the Patents lapsed various companies have tried to secure a footing in the manufacture, but with little encouragement from the British Government, and none at all from the National Telephone Co. This company and our own Government are still practically buying their telephones abroad. A practical electrical expert, Mr. G. Byng, calculates that the total amount so spent since the beginning cannot be much under £30,000,000, and that the loss to Great Britain in wages has equalled half a million sterling per annum for the last quarter of a century." The "expert" we know. The "electrical expert" we have heard of. The "practical electrical expert" is comparatively new as a matter of terminology, but it is trebly valuable in its triple formation. We are sure that the readers of the *National Review*, and the advocates of Patent Reform will accept without question the calculations of an expert who is not only electrical, but who has the additional advantage of being practical. And yet we must express our unfeigned regret that such information should be conveyed with so serious a purpose on such authority as is alleged. The statement does not lack clearness. Let us summarise it: Thirty million pounds have been spent by the National Telephone Co., and the Government on foreign manufactures, and the loss in wages has equalled half a million per annum for the last quarter of a century. And the inference:—Compulsory manufacture in this country by patentees would have saved the country this amount. Notwithstanding that this statement is made by a practical electrical expert, let us consider what basis there is for it.

The accounts of the National Telephone Co. to June 30th last show that the total expenditure on capital account is £12,000,000, and the report of the Postmaster-General for the year ended March 31st last shows that the total capital expenditure on Post Office telephones is under £6,000,000. We do not assume that all possible expenditure on patented apparatus is on capital account. Some apparatus during the life of the service has been charged, doubtless, in whole or in part to revenue. With the figures before us there is no need to split hairs. A practical electrical expert calculates that 30 millions has been spent abroad when 18 millions is the total capital expenditure both at home and abroad. The greater part of this amount has, of necessity, been expended in construction work, manufactured apparatus, whether English or foreign, accounting for only a small fraction. The amount affected by patents must be smaller still, and we do not doubt that proper inquiry would show that the amount involved in the purchase of patented apparatus of foreign manufacture is, compared with the total expenditure, a mere trifle.

There is much more in the article which we should like to deal with, but we have probably said sufficient to enable Sir Joseph Lawrence at his adjourned interview with Mr. Lloyd-George on the 18th inst. to correct some of those misapprehensions which Sir Joseph has been instrumental in circulating. The words of the *Quarterly Reviewer* of 1859 remain true in 1906—"prejudices still exist against patents." The reform proposed may be expedient or it may not, we do not discuss that now—but we are sure that it is necessary to consider the matter from another side. It may be asked, not what have the nation and the industry lost, but rather what have not the nation and the industry gained by the adoption of the most suitable apparatus for carrying on a service without regard to origin? It is clearly useless to ask advocates like Sir Joseph Lawrence and Mr. Byng to consider the possibility of a question having more than one side, but they may be reminded that no useful reform is obtained by the aid of the lowest appeals to prejudice or by the dissemination of statements which—well—lack the essential element of truth.

Oxford's Choice.

What is the matter at Oxford? Events which have recently transpired in that ancient and learned city, in connection with its choice of a system of traction to supersede the totally out-of-date horse tramways at present in use, lead one to surmise that the Corporation, or at any rate, its business-like members, must have been on vacation during the past few weeks.

Having decided, rightly or wrongly, not to admit any system employing an overhead wire, consideration was (or was supposed to be) given to conduit and surface-contact systems. Now, while our opinion in regard to the latter, as a class, has been frequently emphasised, we cannot repress a feeling of mild astonishment that an experimental system, totally untried in this country, and, judging from Press reports, still incomplete in its details, should have been selected in preference to others which are actually operating commercially under the public eye.

That this decision should have been arrived at after visiting both Wolverhampton and Lincoln, where, at the least, a working tramway could be seen, seems remarkable. In both these cases, ordinary English traffic conditions prevail, and such working conditions are apparently met to the satisfaction of the authorities. But no such essential qualification in the case of the system chosen can have influenced the surprising decision of the Oxford Councillors, whose erratic conclusions are even in opposition to their consulting engineer's expressed opinion.

Some light may be thrown on the issue by their antagonism to the old tramway company, who, rightly, put forward the only tried systems. But it is surely not intended that the good folks of Oxford are to be penalised in the future on the former account, for any hypothetical advantage accruing to the town from improved financial terms offered by the accepted tenderers is somewhat discounted under the circumstances.

Of course, it is possible that the Corporation is anxious to shelve the whole matter of tramway reconstruction for a while, in which case, it cannot be denied that its action, judging from the experience of other places will bring about the desired result.

Electric Tube Railways.

Why do American writers persist in the habit of inaccurate statement when they write for the American gallery? We have a notable specimen of this kind of spread-eagle journalism in an article by Mr. Archibald S. Hurd in *Cassier's Magazine*, on what he calls transportation in Great Britain.

To use his own words, "the American capitalist and his attendant engineer appeared on the scene a few years ago, and introduced the 'tube' railway from the Bank of England to Shepherd's Bush, a southern suburb." For multiplicity of errors this sentence takes the palm. American capital had very little to do with the early tube railways, and tube railways were running in London years before the Shepherd's Bush tube. What was American (or German) in that undertaking was the power plant and the electric equipment of the rolling stock only, and Shepherd's Bush is not a southern suburb, though Stockwell is. Before Mr. Hurd again puts pen to paper on the subject of London, he would be well advised to study the topography of the place, and the history of its underground locomotion, from Brunel's great double tunnel onwards. If we have learned anything in this country from America in the way of city locomotion, it is that American methods of railway operation are unsuitable for our conditions, and the latest example of these has done more to damage the cause of electric traction than anything else. Such a crop of troubles has not grown up on any other electrical line than the electrified District, nor is there any other line so much under American control. We owe but little to American teaching in respect of electric underground railways.

CURRENT TRANSFORMERS FOR INSTRUMENTS.

By W. P. F.

On schemes of high and extra-high pressure, safety of operation, immunity from breakdown and simplicity of H.T. connections require that all instruments, relays, &c., should be operated from the secondaries of transformers, the primaries of the same being connected in the main H.T. circuit. Also on low-tension circuits, serious errors due to the effects of eddy currents and stray fields are often eliminated by working the instruments off the secondaries of current transformers, and a considerable reduction in copper connections, with the consequent saving, can often be made by the judicious use of transformers.

On high-tension switchboards immunity from breakdown and simplicity of connections call for the number of transformers to be reduced to the minimum. Continuity of supply demands that instruments may be added or changed, and also transformers replaced, with the smallest delay possible.

In order that the above may be carried out, a transformer should be designed so that:—

1. It will operate the largest number of instruments we may require to connect in series with its secondary (special cases excepted) without impairing its accuracy.
2. The number of such instruments may be changed without recalibration of the instruments left in circuit and without serious error.
3. Serious errors will not be introduced by the variation of frequencies met with in ordinary practice.
4. Serious errors will not be introduced by the power factor of the primary circuit varying from 1 to ·5.
5. Serious errors will not be introduced by change in wave shape of system.
6. The secondaries of all transformers on the switchboard may be of similar design and possess similar characteristics.

Although the above requirements call for a somewhat more expensive type of transformer than many in common use, by careful design such a transformer can be built at a very moderate cost, and when it is considered that a transformer designed on these lines may often replace two and sometimes three of the less expensive type, and also save considerable delay, expense and trouble in calibration, the field for this type of transformer is a very wide one.

The determining features in the design of such a transformer can now be investigated. It is necessary that the secondary current be fixed, together with the maximum E.M.F. that will be required to operate the instruments, &c., and also to overcome the resistance and reactance of the secondary winding.

Let $O C^S$ = the full load secondary current.

$O E^S$ = the full load maximum E.M.F. required at the terminals of the secondary winding + the E.M.F. necessary to overcome the resistance and reactance of the secondary winding.

$O C^M$ = the magnetising amperes corresponding to full load secondary current at maximum E.M.F.

$O C^H$ = core loss component.

$O C^R$ = the resultant of $O C^M$ and $O C^H$.

$O C^P$ = the full load primary current.

Now the per cent. error in ratio $= \dfrac{O C^P - O C^S}{O C^P} \times 100$ per cent.; this will increase as $O E^S$ leads $O C^S$ until the resultant $O C^R$ coincides with $O C^P$, when the per cent. error in ratio is a maximum.

It is also seen that in most cases a difference in phase between primary and secondary currents will exist and will introduce errors in the readings of wattmeters operated from the secondary of the transformer.

Now except in special cases $O E^S$ will lead $O C^S$, by an angle dependent on the reactance of the secondary circuit. If we consider the power factor of the primary circuit fixed for the time being, the error due to this difference of phase will be a maximum when $O E^S$ coincides with $O C^S$, and will

be 0 when o C^R coincides with o C^P, that is, when the error in ratio is a maximum.

The angle representing the maximum difference in phase

$$= \sin^{-1} \frac{o\ C^M}{o\ C^P}.$$

If $\cos \theta =$ the power factor of the primary circuit, then the maximum error due to difference in phase in per cent.

$$= 100 \left\{ \frac{\cos \theta - \cos \left(\theta - \sin^{-1} \frac{o\ C^M}{o\ C^P} \right)}{\cos \theta} \right\}$$

If for any transformer a magnetising and core loss current is assumed, the maximum error due to ratio and phase

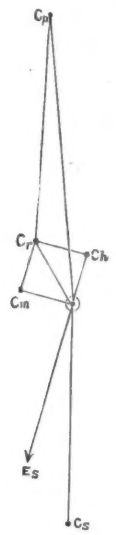


Fig. 1.

difference at full load and maximum secondary E.M.F. can be closely approximated.

If o C^M is assumed to be 2 per cent. of o C^P,

and o C^H „ „ 2 „ of o C ;

then the maximum errors, with varying power factor of the primary circuit when o E^S coincides with o C^S, will be as follows :—

	← Lead.					← Lag.							
Power factor main circuit	·8	·85	·9	·95	1	·95	·9	·85	·8	·75	·7	·65	·6
Max. error due to phase difference	−1·22	−1·07	− ·89	− ·64	0	+ ·64	+ ·89	+1·07	+1·22	+1·35	+1·44	+1·54	+1·61
Ratio error when phase error is a maximum	−2	−2	−2	−2	−2	−2	−2	−2	−2	−2	−2	−2	−2
Combined error per cent.	−3·22	−3·07	−2·89	−2·64	−2	−1·36	−1·11	− ·93	− ·78	− ·65	− ·56	− ·46	− ·39

The maximum error when o C^R coincides with o C^P will be − 2·88 per cent. ; under this condition the phase error = 0 for all values of power factor of the primary circuit.

Referring to the errors given in the above table, the errors due to phase difference are for an extreme case, and rarely if ever in practice will the error reach the maximum value.

Also when a wattmeter is worked off a potential transformer, the difference in phase between the secondary and primary volts of the potential transformer will partly, and under some circumstances, eliminate this error.

From the above figures it is seen that the extreme variation of accuracy will be from 0 to − 3·22 per cent., and the probable variation will be from 0 to − 2·88 per cent.

The transformer may be wound with an initial inaccuracy of, say, + 1·6 per cent., this will give the probable variation from + 1·6 per cent. to − 1·28 per cent.

In order that a satisfactory transformer may be designed leakage must be reduced to the minimum, as its effect is to increase the secondary E.M.F. necessary to overcome the reactance of the secondary winding, thereby increasing the flux, magnetising current and core loss component, which means an increase in the errors of the transformer.

It will be found that the number of ampere-turns on the transformer can not be reduced below a certain number dependent on the values of o C^S and o E^S required.

The quality of iron used for the core should be of the best quality obtainable, so that core loss and reluctance may be reduced to the utmost ; the iron must also be free from ageing.

The magnetic circuit should be jointless, as the presence of joints materially increases the reluctance of the magnetic circuit.

The density in the primary winding should be run as high as is consistent with safety, so that the area taken up by the primary winding may be small and the length of magnetic path reduced as far as possible. A consideration of the above requirements would lead to the adoption of the ring type of current transformer, in which the core consists of an annular ring made up from jointless laminations, the secondary winding being wound next to the core and distributed evenly around the same.

This type also has the advantage of being easily and safely insulated for the higher voltages.

With this construction it will be found that values of magnetising and core loss current as assumed above, can easily be attained for a transformer which will operate the largest number of instruments, relays, &c., that may be connected in circuit with the same, when the worse conditions of frequency and wave form met with in ordinary practice are assumed.

In order that transformers with different ratios may be of exactly similar design and possess similar characteristics, it is well to choose such a number of secondary turns (leaving for the moment the advisability of winding with an initial error), that it is divisable by as many whole numbers as possible, so that the ratios of transformers may be varied by altering the primary turns, the secondary winding remaining the same for all ratios, those ratios being whole numbers.

An interesting point occurs when dealing with current transformers, and one that is often disregarded. If the secondary of a current transformer be open circuited when the primary is connected in circuit with load on, a step up transformer exists with highly saturated core and consequent heating. The saturation of the core limits the virtual value of the E.M.F. between the terminals of the secondary winding, but the rapid change of flux in the core (at the time when the flux is just reversing) induces high instantaneous values of E.M.F. in the coils of the transformer, the volt curve being a series of peaks. Due precaution should be taken to prevent transformers of this type being left with secondaries open when the load is on the primary winding.

Industrial Exhibition at Liverpool.—We have received a copy of a preliminary prospectus concerning the Liverpool Polytechnic Industrial Exhibition, which is to be held from December 1st to February 2nd next, with a view to placing manufactures and industries before the public in a popular manner, and at the same time providing musical entertainments for the people during the winter months. The list of sections includes one relating to engineering and machinery, and one for illuminants and power producers (gas and electricity). Full particulars can be obtained from Mr. Henry W. Pearson, general manager, New Exhibition Hall, Dansie Street, Liverpool.

TRADE STATISTICS OF THE TRANSVAAL.

The following statement of the imports of electrical and other material into the Transvaal is extracted from the recently published Annual Trade Statistics of that Colony; similar details for 1904 are given for purposes of comparison:—

	1904.	1905.
Electrical Fittings.—		
United Kingdom	£20,388	£33,075
United States	6,553	8,853
Germany	5,876	2,845
Other countries	1,137	1,125
Total	£33,954	£45,898
Electrical Machinery.—		
United Kingdom	£62,754	£79,742
Germany	31,151	31,766
United States	21,487	16,150
Other countries	2,014	5,052
Total	£117,406	£132,710
Mining Machinery.—		
United Kingdom	£475,638	£463,474
Germany	41,003	125,442
United States	197,007	155,718
Other countries	5,184	6,081
Total	£718,832	£750,715
Other Machinery (except Agricultural and Manufacturing).—		
United Kingdom	£192,999	£383,053
Germany	28,649	51,207
United States	48,493	78,667
Other countries	9,843	11,643
Total	£279,984	£524,570
Tramway Material.—		
United Kingdom	£99,429	£74,991
Germany	50,719	63,847
United States	9,230	2,186
Other countries	13,610	6,854
Total	£172,988	£147,878
Electrical Cable and Wire.—		
United Kingdom	£38,715	£103,567
Germany	2,249	4,836
United States	1,563	1,646
Other countries	809	3,692
Total	£43,336	£113,741

THREE-PHASE TRANSMISSION AT 25,000 VOLTS.

Important electrical works have recently been established by the Conti Electrical Undertaking Co. for the supply of energy in the industrial area of the Brianza. The River Brembo, with a collecting watershed nearly 500 kilometres square, is tapped by a canal that has been formed for the purpose of the electrical works—partly in open cutting and partly in tunnel—for a length of 8 kilometres. This has enabled the undertakers to obtain a fall of 58 metres near Zogno, whilst the capacity of the canal allows a flow of 10 cb. metres per second, so that about 7,700 h.p. is available at the intakes of the turbine house. The weir is constructed of armoured-cement concrete, covered with rough cut stones, laid in courses diagonally to the level of the water. The length of the weir is 51 metres, and its greatest width near the centre is nearly 18 metres. In front of the sluice gates giving entrance to the canal, deep holes have been constructed in the bed to collect any large stones brought down with the torrent that might cause damage to the gates; the water passes through strainers at the power house to prevent the smaller foreign matter from getting into the turbines. At the overflow near the power house, special precautions have been taken to avoid the spray that would be caused by the water falling in the open; it being taken through a sloping tunnel with a final fall of only 6 metres at some distance from the high-pressure machinery.

The turbine house is 40½ metres long by 14 metres wide, with a height of 12 metres. Advantage is actually taken of 55 metres of the total fall of 57 metres, and connections made to four direct-coupled turbo-generators, each of 2,000 h.p., of which one is in reserve. On the hydraulic side, the machinery has all been constructed by Messrs. Riva, Monneret & Co., of Milan, and the electrical machines by Messrs. Gadda & Co., also of Milan. The latter firm have, in addition, carried out the scheme of distribution. There are two direct-coupled sets of exciters. The speed of the large machines is 315 r.p.m., giving a frequency of 42, the armatures being stationary and wound for a pressure of 2,750 volts, this being increased to 25,000 volts for transmission. The coils are all former wound and laid in open slots round the armature, with insulating material between. The pole-pieces of the revolving magnets are bridged across with suitably shaped pieces of bronze to give the greatest possible strength against breakage by centrifugal force, and the magnets are wound with copper tape, put on edgewise. All the bearings are provided with water circulation for cooling purposes.

The partitions dividing the various parts of the switchgear are constructed of armoured concrete. The high pressure sides of the step-up transformers are controlled by switches worked from hand-wheels, the actual switches being located in the transformer chamber. All the measuring instruments on the distribution switchboard, indicating the energy going out to the circuits, are connected to auxiliary transformers, so that there is no wire on the board at extra-high pressure. The exciters are also controlled from apparatus on the distribution board, so that the lower portion of the main board controls solely the supply from the alternators to the step-up transformers all at the pressure of 2,750 volts, through measuring instruments and oil switches.

The three-phase current at 2,750 volts pressure is raised to 25,000 volts by four groups of transformers, each group consisting of three single-phase transformers of 600 kw. capacity; they are cooled by forced draught provided by electrically-driven ventilating fans, one for each group. All the electrical connections are carried under the floor by the shortest possible route to the controlling switches, so that there is no encumbrance to free passage to any part of the chamber.

The overhead transmission lines are connected to lightning arresters of the Gola, Siemens and Wurts patterns in the roof of the building, every pole of each line being so protected. All the sub-stations are in direct communication by telephone with the generating station at Zogno.

THE INDUSTRIAL POWER PROBLEM.

By W. B. ESSON, M.Inst.C.E., M.I.E.E.

(*Abstract of Presidential Address to the* Civil and Mechanical Engineers' Society, *delivered on October 4th*, 1906.)

Everyone is interested directly or indirectly in the cost of power, because the lower the price at which it can be obtained, the cheaper can articles of daily use be produced and the cheaper can they be bought. To us as engineers the subject of producing and distributing power at the lowest cost should have special interest, and in this paper an attempt will be made to discuss within a short space the present position in power affairs.

Before dealing with the distribution of power from a general power house, let us consider the simple case of a factory having to be furnished with power from power-producing plant located on the premises. We have the choice of steam, gas, or oil engines, and we shall assume that the driving requirements will be met by an engine of 500 b.h.p. For the more economical distribution of the power throughout the works electricity will be employed, so in each case an electric generator will have to be coupled direct to the engine shaft. This generator will give a maximum of about 470 e.h.p., and, running for 2,800 hours per annum, we will take the electrical output as one million e.h.p.-hours yearly. Throughout this paper, unless otherwise stated, it will be understood that the power is always delivered in the electrical form.

Beginning with the steam engine, this has in recent years reached such a high state of efficiency that little or nothing in the way of improvement can be looked for in the future. A triple-expansion engine of the size mentioned running condensing at 300 r.p.m. with 150 lb. pressure, and, say, 100° superheat, will require no more than 14 lb. of steam per e.h.p. per hour at full load, or 16 lb. at half load, or working non-condensing 20 lb. and 24 lb. respectively. The boilers, steam and exhaust piping, feed pumps, heater, &c., must all be regarded as part and parcel of the power equipment. As in different types of engine the disparity between the fuel consumption at full and reduced load is not the same, we will take in all cases the mean consumption between full load and half load, and there is no doubt that under this assumption, with the power-producing plant carefully designed throughout, we can easily get when working condensing and with superheat an e.h.p.-hour for every 2·25 lb. of bituminous slack consumed in the furnaces. This makes ample allowance for the steam used in the auxiliary plant and for the coal used in lighting up, &c. As this class of fuel can be obtained in the manufacturing districts at a cost of 7s. 6d. per ton delivered in the boiler house, or about 25 lb. for 1d., it will be seen that for steam plant the cost of an e.h.p., so far as the fuel is concerned, works out at ·09d. per hour.

Let us see now what we can do with a gas engine using producer gas. In the early forms of producer for making power gas, only anthracite coal or coke could be used, both of which consist almost wholly of pure carbon. For suction gas these are still the only fuels which can be employed, and, needless to say, they are very expensive as compared with bituminous slack. But the problem of using this latter fuel for power gas manufacture has been completely solved in the Mond producer, and there are at present working with Mond gas, engines giving an aggregate of about 60,000 b.h.p.

When working this system on a large scale, it pays to recover the ammonia, which is washed out of the gas before it is suitable for burning in engines.

We can gasify, then, for working our engines the dearer anthracite or the cheaper slack. Taking the former, which produces gas having a calorific value of about 150 B.TH.U. per cb. ft., the makers of the plant will guarantee that the consumption of anthracite coal in the suction gas installation per hour shall not exceed ·8 lb. per E.H.P. at full load, or 1·2 lb. per E.H.P. at half load. Taking the average of these figures, if we reckon that anthracite peas can be purchased in the manufacturing districts at 24s. per ton, it will be seen that the fuel cost per E.H.P. is about ·129d. per hour. If the power happens to be wanted where Scotch anthracite peas can be delivered at 9s. 3d. per ton, as was the case on the occasion of the trials at the Highland and Agricultural Society's Glasgow Show in 1905, the figure will, of course, be much lower.

Dealing now with slack, we will assume that this can be delivered at a cost of 7s. 6d. per ton at the works. The Mond gas made from it has a calorific value of about 150 B.TH.U. per cb. ft. A good engine will give an E.H.P. for every 75 cb. ft. of gas consumed per hour, and as the gasification of a ton of slack produces about 150,000 cb. ft. of gas, calculation shows that the cost per E.H.P. per hour for fuel amounts at full load to about ·045d. At half-load this becomes ·057d., the mean being ·051d. As confirming this, the test of a 500-H.P. engine coupled to a generator has shown, when running on two-thirds load, a consumption of 1·26 lb. of slack per E.H.P. As it does not pay to recover ammonia in a plant of less than 20,000 H P., we can, in the present instance, get no credit on this account.

Coming to oil engines, oil suitable for Diesel engines now costs in London 42s. 6d. per ton, and carriage added will bring the price up to, say, 45s. The Diesel Engine Co. will guarantee that for an engine of the size we are considering the consumption of this oil, which has a calorific value of 18,000 B.TH.U. per lb., shall not exceed ·48 lb. per E.H.P. per hour at full load, or ·56 lb. at half load. Taking the mean between these two figures, the fuel cost for the engine works out at ·125d. per E H.P.

The Mond gas plant, on the assumptions made as regards the cost of fuel per ton, easily distances its competitors in economy. The figures are:—

Mond gas...	·051 of a penny per E.H.P. per hour.	
Suction gas	·129	" " "
Steam (condensing) ...	·090	" " "
Steam (non-condensing)	·120	" " "
Oil	·125	" " "

These figures have been obtained under usual test conditions, and are just as valuable in giving an indication of what may be expected from the different plants as any figures can be.

It may be that water has also to be paid for. For the steam engine there is some make-up water to be provided for condensing and for boiler feed. For the gas and oil engines there is also make-up wanted for the cylinder cooling water, while for the gas engine there is required water for the producer in addition. For cooling there would require to be circulated round the cylinders of the oil engine about 4 gallons of water per E.H.P. per hour, and round the cylinders of the gas engine about 8 gallons per E.H.P. per hour. The circulating water required for condensation in the steam engine would be about 45 gallons per E.H.P. per hour, and if we assume that there will be lost in evaporation in the cooling towers 3 per cent. of the circulating water, this means that a total make-up of 60 gallons, 120 gallons, and 630 gallons is required per hour for the oil, gas and steam engines respectively. As regards the water entering the gas producer, this would amount to one-eighth of a gallon per E.H.P. per hour, which means that rather over a ton of water has to be sucked or blown into the producer for every ton of coal gasified. Then there is the water for cooling and washing the gas, which amounts to 1½ gallons per E.H.P.

In the matter of cylinder lubricant, the steam engine has some advantage, though otherwise the cost of oil is the same. As regards maintenance, many people have the impression that a gas engine requires to have spent on it a much larger amount than does a steam engine. No doubt experience in the past has given encouragement to this view, but as time goes on the maintenance cost is likely to fall below that on steam plant. In the wages for attendance there is no difference to speak of. Obviously, as compared with steam plant, there is with gas plant about half the amount of fuel to be dealt with, while in working the oil plant is by far the cleanest.

Summing up the running charges for the various plants we have the following:—

—	Mond gas.	Suction gas.	Steam (cond.).	Steam (non-cond.).	Oil.
Fuel	·051d.	·129d.	·090d.	·120d.	·125d.
Oil, water and stores	·030d.	·030d.	·025d.	·026d.	·025d.
Wages	·070d.	·070d.	·070d.	·070d.	·065d.
Maintenance and repairs	·075d.	·070d.	·070d.	·068d.	·065d.
Works cost ...	·226d.	·299d.	·255d.	·284d.	·280d.

The capital which would be expended on the various plants, including the electric generator and main switchboard, but excluding everything outside the power house, is set out as follows:—

Mond gas.	Suction gas.	Steam (condensing).	Steam (non-condensing).	Oil.
£6,710	£5,150	£5,400	£4,900	£6,850

These estimates are made up from firm tenders, but as the completed cost would depend, to some extent, upon where the plant is installed, they must be taken as approximate only.

Adding to the figures of works cost, for interest on the capital outlay and depreciation, 10 per cent. per annum, we have, on the basis of a million E.H.P.-hours per annum, to charge each E.H.P.-hour with an amount as under:—

—	Mond gas.	Suction gas.	Steam (cond.).	Steam (non-cond.).	Oil.
Works cost ...	·226d.	·299d.	·255d.	·284d.	·280d.
Capital charges ...	·161d.	·124d.	·130d.	·118d.	·164d.
Total cost	·387d.	·423d.	·385d.	·402d.	·444d.

From these figures it will be seen that when any considerable amount of power is required, it can be produced on the consumers' premises at a cost of between ·385d. and ·444d. per E.H.P.-hour, according to the plant employed. In getting out these costs the simplest case of one generator has been taken, which, of course, makes the capital cost lower than if the generating portion of the plant were split into two units, each of one-half the size. The object in dividing the plant would be to secure economy in steam consumption in the case of underloading, while incidentally the danger of a complete shut-down of the power plant would be removed. With the whole of the works supplied from one power house, it is certainly advisable to have two sets of generating units. By this variation, the capital charges are increased by 15 per cent. for steam, 18 per cent. for Mond gas, 22 per cent. for suction gas, and 25 per cent. for oil. The lowest cost is ·4d. per E.H.P.-hour, and in no case is a halfpenny exceeded. The question is, can the companies who undertake to deliver power from a general power house beat this?

Let us consider the circumstances affecting supply of power from a general power house, premising at the outset that electricity furnishes the only means by which such distribution can be successfully carried out. Though looked after most carefully, and though maintained in a state of first-class repair, machinery must necessarily wear out some day. It is to provide against this evil day that a depreciation fund must be built up, the theory being that the actual value of the machinery at any particular time, *plus* the amount standing to the credit of the fund, shall together be equal to the original value of the machinery on the day on which it was set to work. Payments to an assurance company in the shape of annual premiums equal to 2½ per cent. per annum on the sum advanced will have accumulated to the full value of the sum in about 26 years, and it may be taken, therefore, that an all-round allowance of 2½ per cent. on the capital outlay will constitute sufficient provision for depreciation in the case of power generating works. The amount allowed by the London Supply Companies for last year averaged just over 2 per cent.

We will take it, then, that 2½ per cent. on the capital outlay represents a fair annual contribution to depreciation, and it will be assumed that, when the undertaking has reached its ultimate capacity, there is the same amount of share and loan capital. Calculating on a dividend to shareholders of 10 per cent. per annum, and on interest to debenture-holders at 5 per cent., this amounts to paying on the whole capital interest at the rate of 7½ per cent., and with 2½ per cent. for depreciation the annual obligation in respect of capital amounts to 10 per cent. The amount actually assignable to each H.P.-hour depends upon the amount of capital invested and on the number of H.P.-hours sold. The expenditure on each H.P. of plant capacity depends upon many conditions. If it is desired to supply power cheaply, the power-house must be built on cheap land; the site must be chosen where regard for appearance has not to be studied, but where the only thing which need be kept in mind is the object for which the buildings are put up.

The last and most important factor influencing the outlay is the cost of the generating machinery and equipment. If steam turbines are used the cost per H.P. installed is less for large generating sets than for small ones; as these take up much less space for the power installed, the buildings can be made relatively smaller and the capital cost reduced all round. With respect to fuel economy, with increase in size the steam used per H.P. per hour diminishes, and at partial load large sets may actually use less steam for the same power than smaller sets running at full load. There is also economy in labour, as large sets require no more attention in running than small ones.

Recently several estimates have been published showing what large power houses should cost with turbo-generating plant installed and everything carried out on the most up-to-date lines. The Carville power house of the Newcastle-on-Tyne Co. has a capacity of 13,000 E.H.P., and cost £12 per E.H.P. The Lot's Road power house of the Underground Electric Railways Co., with a capacity of 100,000 E.H.P., is said to have cost £13 per E.H.P. The latest figures of all are for the power house proposed to be erected at Battersea according to the London County Council's 1906 Bill, which was to have a capacity of 107,000 E.H.P., and was estimated to cost £11·25 per E.H.P. The cost of the distributing system depends upon many circumstances, such as the number, size, and length of feeding and distributing mains, the route they have to take, the number of sub-stations required, &c., all of which vary according to the scheme and the district for which it is devised.

To get at the cost at which power can be supplied to customers, let us assume that we put down a power house having a capacity of 20,000 E.H.P. From the foregoing figures it would appear that £12 per E.H.P. is a fair estimate for the cost of generating plant and buildings, including incidental changes, while the distributing system may also be taken as costing £12 per E.H.P. This is a much lower figure than has yet been found possible for the all-round cost of any undertaking. If we assume that the H.P.-hours per annum reach 40,000,000, which, taking into account the loss in distributing, corresponds to a load factor of nearly ·29, this means that the capital charge to cover interest and depreciation reckoned at 10 per cent. on the outlay will amount, in respect of each H.P.-hour, to ·288d. The capital cost of the power house and distributing system is £480,000. It may interest you to know that in the Newcastle-on-Tyne concern, which has been brought so prominently before our notice, and which supplies the same amount of power, the total capital embarked amounts to £1,192,400.

Taking everything into account, and with the experience to hand, it would, I consider, be unwise to assume that the cost of generating and distributing could for a power house of this size be brought under ¼d. per H.P.-hour sold, and this is taking coal at 7s. 6d. per ton. After works cost come rent, rates and taxes, then directors' fees, cost of administration, and all the miscellaneous items which make up the head office charges in the engineering and business departments. As regards rents, rates and taxes, these items vary with the locality, but at ·03d. per H.P.-hour we are putting them at a low figure. In London the undertaking with the greatest output pays more than four times this. At Newcastle-on-Tyne the figure is about ·07d., and at Manchester and Liverpool it is ·10d. Then we have the cost of administration, and here let me say that to find customers for the output of a large power station requires constant and unremitting effort and a staff to correspond. In putting the cost of this last item and the items not yet accounted for at ·06d., we have, I consider, got down to bedrock. In the Newcastle-on-Tyne concern, where the amount of power sold is the same, and where the management is particularly energetic in pushing business, the figure reaches no less than ·14d. Our cost per E.H.P. is, therefore:—Generating, ·25d.; rent, rates, &c., ·03d.; administration, ·06d.; capital charges, ·288d.; total, ·628d. The conclusion is that unless the undertaking can secure an all-round price of about five-eighths of a penny per H.P.-hour, it will not, under the conditions we have assumed, pay the dividends it set out to earn, and if it has to supply below this price, the dividend will shrink to correspond. If shareholders would be content with 6 per cent. on their investment, and lenders with 4, presuming all our figures are correct, the price might possibly be brought down to nine-sixteenths of a penny.

Several of the London undertakings supply power at ¾d. per E.H.P.-hour; the total cost of production, excluding capital charges, amounts to something over 1d., and only because a large portion of the output is sold at a comparatively high price for lighting can the power portion be supplied at a price which carries no administration or capital charges. Dumping units to fill in the valleys in load curves is a good thing, but when, owing to the loads overlapping, the generators must be set aside to supply power *or* lighting, but not both, obviously lighting pays better.

Though our figures show that it will pay the large consumer better to use home-made power than to purchase companies' power, there are thousands of small consumers, whose power plant is generally of the poorest, to whom a cheap supply from the companies must prove an inestimable boon. The prices of all power machinery have fallen enormously in the course of the last few years. Now, the manufacturer who generates his own power can take full advantage of the low prices for plant, and can erect suitable buildings very cheaply. There is not much difference in cost per H.P. between the plant for the large power house and the plant for the smaller installation, the advantage due to the employment of large generating sets in the former being counterbalanced by the extreme simplicity of the latter. Again, for an isolated plant there is no general distribution system, so the total cost of small plant per H.P. falls much below that of the large power house. The interest chargeable in respect of the cost of supply mains may, on each H.P.-hour supplied by a company, amount to as much or more than the interest chargeable in respect of the generating plant, and this the man who has his own installation saves. Finally, he need not charge himself for securing his own business; consequently administration charges do not figure in the accounts.

Though it may pay to generate the power on site, considered from the purely investment point of view, the margin is not large, and if the companies can come within reasonable distance of the price I have mentioned they will be sure to secure a goodly number of large consumers. The reason is that to compete with the power companies the equipment in the factory must be of the highest efficiency, and to get up-to-date equipment the power user would have to spend money. That, needless to say, is precisely what he does not want to do, and often he has not the money lying by to spend. As a rule a manufacturer will do anything rather than put down hard cash to improve his plant, and the companies, knowing this, must be ready to put it down for him.

The Power Gas Corporation has been good enough to hand me a complete estimate for a power station of 20,000 E.H.P., equipped with gas engines and Mond gas plant. Eight engines are proposed, each giving 2,500 H.P., and provision is made for recovering the ammonia as a by-product from the gas producers. It may be said that gas engines much larger than the above are in satisfactory work, so there is nothing speculative about the undertaking. In a week or two a 2,000-H.P. engine will be set to work in this country, and in America the largest engine yet made giving 4,500 H.P. is working regularly and satisfactorily with natural gas. The tender for the complete power house is £256,000, which works out at £12·8 per E.H.P., or about the same as a steam power house. As regards running costs, I have not been able yet to check the Corporation's figures, but one circumstance stands out in the boldest relief, and that is, that the cost of the fuel is wholly recovered in the value of ammonia sulphate obtained from its gasification. Whether there is any set-off against this in the form of extra labour or expense in attending to the gas and ammonia plant over that of attending to an ordinary boiler house is at present a matter of inquiry, but that only about half the weight of fuel requires to be dealt with has been already pointed out. I have the greatest confidence in the future of this principle by which waste is eliminated and valuable by-products recovered. There is a wide field for its application, and it will no doubt influence to a large extent future developments in the domain of power distribution.

I have said that, as a means of distributing power, electricity has no competitor, but recently efforts have been made to distribute not power, but fuel in the form of Mond gas, which may suit the requirements of some manufacturers better than power delivered electrically. The gas can be used either in gas engines for driving purposes, or for heating, and the South Staffordshire Mond Gas Co. is the pioneer of this development. The company has laid about 30 miles of pipes, and delivers gas between six and seven miles from the generating house. During the first six months of this year there were delivered from the mains of the company to customers over 1,700 million cb. ft., at an average price of rather under 2d. per 1,000. Taking 80 ft. per E.H.P.-hour as the consumption for the usual size of gas engine met with, this means that the fuel cost amounts to ·16d. per E.H.P.-hour. This is about what suction gat costs when generated on site, labour and capital charges in respects of the plant being included. I learn that the aggregate capacity of all the Mond gas plants at work gives an equivalent of about 240,000 B.H.P.; but as three-fourths of the gas is used for heating metallurgical furnaces and for other purposes where heat is required, it appears that power will not form the company's chief source of revenue. In districts where heat as well as power is wanted, the system has every chance of success. There are no serious engineering difficulties in the way, and it must be remembered that gas distribution on a large scale for lighting is already an existing thing. If all the gas distributed from the eight stations of the London Gas Light and Coke Co. were used for power purposes, it would represent 450,000 H.P. of gas engines running continuously for 3,000 hours per annum. The combined output of the 62 electrical stations in London represents under 60,000 H.P. for the same period.

Another advance in the direction of distributing fuel gas is proposed for Cumberland. The idea is to erect power houses at Maryport, Workington and Cleaton Moor, and arrangements have been made to utilise the waste gases from the blast furnaces of the three greatest ironworks. Part of the gas will be used in engines for generating electricity, and the remainder distributed. It is estimated that gas representing 60,000 H.P. is being dissipated continuously from these furnaces. Think of it! and reflect also on the enormous waste of a similar kind going on all over the country from both blast furnaces and coke ovens.

LEGAL.

Hastings Electric Tramways Co.

In the Vacation Court on Wednesday last week, before Mr. Justice Bargrave Deane, Mr. Roskill, K.C., moved, on behalf of the Hastings Electric Tramways Co., for an injunction to restrain the Hastings and St. Leonards Gas Co. from proceeding further with an arbitration.

Counsel said that the question arose under the Tramways Act of 1870, and the point, though important, was a short one. The tramways in question were being laid under an Act of Parliament of 1903, which incorporated the Tramways Act of 1870, and the point arose under Section 30, which provided that, for the purpose of making, forming, laying down, maintaining, and so on, the tramways, the promoters might, from time to time, where, and as far as it was necessary to prevent frequent interruptions or repairs, alter the position of the gas mains, subject to giving seven days' notice to the Gas Co. and providing them with plans and sections of the proposed work. If, on receipt of that notice, it appeared to the Gas Co. that the construction of the tramlines would endanger their pipes or mains, they might, within the seven days, require the promoters to lower or otherwise alter the position of the mains or pipes, any difference arising to be submitted to an arbitrator appointed by the Board of Trade. On June 1st the plaintiffs gave the notice required by Sec. 30 of the Act, but they heard nothing from the defendants until the 26th, and then only upon a question as to the depth of concrete. The promoters were under a statutory obligation to restore the road for traffic purposes within four weeks of the notice given to the Corporation, and failure to do so rendered them liable to a penalty of £5 a day. It followed under these circumstances that there was an absolute obligation on the Gas Co. to serve the promoters with what he might call a counter notice requiring the Tramways Co. to alter the position of the mains or pipes, and failure to do so within seven days put an end to their right to arbitration. They must then either alter the mains them-

selves or pursue the other remedies under the Gas Works Clauses at their own expense. Having allowed the seven days to expire without giving the counter notice under Sec. 30 requiring the promoters to alter the position of the mains, &c., no necessity for arbitration arose, and no right to arbitration could, therefore, accrue to the Gas Co.

Mr. Bramwell Davis, K.C., who appeared for the Gas Co., contended that on the law the Court had no jurisdiction to grant any interlocutory injunction as was asked for by the other side.

His Lordship said he did not think this was a case in which he should make any order in the vacation.

Mr. Roskill asked for a stay pending an application to the Court of Appeal.

His Lordship: No, I cannot do that, as it would amount to granting an interlocutory injunction.

CORRESPONDENCE.

Letters received by us after 5 p.m. on Tuesday cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

Lightning Effects on Underground Mains.

I am pleased to bring before your readers what, to me, appears to be a most unusual occurrence ; in fact, I have never heard of any previous cases.

On Monday evening last, October 1st, a very heavy thunderstorm passed over here about 7 p.m., accompanied by an extremely vivid flash of lightning, and I was surprised to learn next morning that one of our consumers' service fuses had been blown exactly at the same time as the flash occurred. For confirmation I may say that a neighbouring grocer had a large stock of matches set on fire by the lightning at the self-same period. The installation to which I refer is a small factory with glass roof, and, as far as I learn, the lightning would pass through the glass and strike the neutral pole which is at earth potential ; the fuse-box in question is one with glass front and a three-core service. Again, another installation where the fuses of the service were burnt out in the house service cut-out box, but in this case both positive and negative fuses were destroyed. In the two cases I mention, the lights were burning up to the time of the storm occurring.

I may add, in conclusion, no damage occurred at the works. It would be interesting to know if any other reader knows of any such occurrences.

Joseph Ainscough,
Chief Assistant Engineer.

Kendal Electricity Works,
October 3rd, 1906.

[A similar phenomenon was recorded in our issue of August 31st last, p. 347.—Eds. E.R.]

Efficiency of Electricity Generating Stations.

The article entitled "A Method of Comparing the efficiencies of Electricity Generating Stations," by C. J. Evans, appearing in your issue of September 28th, emphasises the unnecessary trouble occasioned by the various different systems of units with which we are still burdened.

It seems to me that the case before us is one where the desirability is pronounced of expressing all quantities involving energy, of whatever form, in one single unit, and dispensing will all other units for this field of calculations. There should not be much doubt to electrical engineers as to what is the unit they should employ, as we have the KW.-hour firmly established by the Board of Trade as the unit of electrical energy.

As all electrical energy supplied and delivered from the switchboards is metered in Board of Trade units, *i.e.*, in KW.-hours, it is evident that the power station engineer would do well to express his coal energy also in the KW-hour, and dispose of the B.TH.U., and with it, so far as calculations in his sphere are concerned, the H.P.-hour, the foot-pound and the calorie, and all the other energy units.

Mr. Evans's paper would have been more consistent as appearing in an electrical engineering journal, and coming presumably from an *electrical* engineer, had he stated the thermal efficiency as the ratio of the energy delivered from switchboard to the energy in the coal consumed to obtain this energy with the energy expressed in *any one* unit, and this unit preferably the KW.-hour.

The expression "British thermal units per Board of Trade unit" conveys no idea of the efficiency unless one knows the relation between the two units (which generally means a hunt in a pocket-book), and to state the "thermal efficiency" is infinitely superior.

Further, if we had our coal quality expressed in KW.-hour per ton, we could form at once some idea of how many tons of coal would be required for a certain number of standard lamps—for instance, whereas that a ton of coal contains so and so many British thermal units conveys next to nothing to an electrical engineer, as he knows the efficiency of his lamps in candle-hours per KW.-hour (*i.e.*, candle-power per watt), not in candle-hours per B.TH.U.

We have a plaint against the publishers of statistics, if the energy in the fuel and in the electrical end are expressed in units of opposing systems. This, of course, is due to our multitude of units ; and why not let us, as electrical engineers with our standarised Board of Trade unit, have the KW.-hour throughout as the only unit of energy. There is no reason why, because the energy is in a different form, whether electrical or heat, it should require a different unit for each form. I should like, if you will allow me, in connection with this matter to refer your readers to an article by Mr. H. M. Hobart which appeared in your issues of April 27th and May 4th this year, entitled "The Advantages of Employing Electrical Engineering Nomenclature in Steam Engineering Calculations," which demonstrates thoroughly the convenience of a single unit, and that the KW.-hour.

For example, if a station supplied during the year 1·5 million KW.-hour from the switchboard, and the annual coal consumption is 6,700 tons, then if we have stated the calorific value of the fuel as 7,500 KW.-hour per ton, the energy taken from the coal pile during the year is $6{,}700 \times 7{,}500 = 50$ million KW.-hour, and the annual overall efficiency simply $\frac{1{\cdot}5}{50} = 3{\cdot}0$ per cent. without the worry of the B.TH.U. or the number of B.TH.U. equivalent to a KW.-hour.

This attitude should not be regarded as merely a "metric fad" (probably the kilogramme meter or the kilogramme calorie would be more truly the metric unit), but it should appeal as the rational basis, at any rate, to electrical engineers.

A. G. Ellis.

London, W.C., *October 3rd*, 1906.

Application of Magnetic Brakes.

As I am unaware that my suggestion at the Municipal Tramways Conference of energising magnetic disk of track brakes direct from the trolley wire has been tried on any system (with the exception of Sheffield), it may interest your readers to know that the writer carried out experiments some few years ago, with an automatic switch which operated when a predetermined speed was attained and cut off power to the motors and energised the magnetic brakes direct from the trolley line through the ordinary resistance carried on the car. It was found that a car travelling at a speed of 12 miles per hour on the level could be stopped in from 20 to 30 yd. by this method, and as it undoubtedly puts much extra work on the motors when they are used in conjunction with track brakes (which have been known to fail through various causes—principally dirty commutators), I see no reason why the track brakes should not be energised from the power supply, either from the controller or an auxiliary switch.

It may be said that the method would be expensive where current is purchased at a high price, yet according to Mr. Mozley's experience it would be cheaper than dismantling equipments and renewing armatures.

As the majority of runaway cars have been caused by the vigorous application of the hand brakes, thereby locking the wheels and making the magnetic track brakes inoperative, it will be seen that the track brake when energised by the power circuit, is effective even if the wheels are locked, and

in the event of the trolley coming off the wire or the power failing, the motors could then be short-circuited in the ordinary way (provided, of course, that the wheels were not locked by the hand brake).

H. E. Yerbury,
Chief Electrical Engineer.

Sheffield Corporation Tramways,
October 2nd, 1906.

The Penetrating Properties of the Arc Light.

I was much interested in Mr. Bastian's further letter on this subject, for the reason that whereas he had previously given the "blue colour of distant objects" as the chief fact (?) in favour of his views, he has now evidently realised that distant objects do not appear blue, but that the atmosphere between does. Then he states that my theory of the blue colour of the sky requires the admission that the atmosphere is filled with solid particles of a uniform size, whereas it means nothing of the kind. According to that theory the smallest particles reflect ultra-violet light only, slightly larger ones reflect ultra-violet and also visible violet, slightly larger give all the most refrangible rays as far as the blue, and each increase in size means more of the spectrum, until with all sizes of the particles we have the whole of the spectrum with a preponderance of the violet-blue.

If the atmosphere were a blue transparent body the sun would appear to become increasingly bluer as it declined from the zenith to the horizon, whereas it actually gets steadily redder.

We now come to the question of the apparently greater absorption of light from more intense sources. This I shall also show to be due to the greater absorption of red rays. Since, in the case of the incandescent solids, the flux of light per square centimetre of radiating surface increases with the temperature, and since the colour of the light becomes bluer at the same time, in general it will be found that a low intensity source is redder than a high intensity source, and the greater absorption of light from the latter is due, not to the greater intensity, but to the light being bluer.

Mr. Bastian, of course, will not allow this, and so has to put the increased absorption down to the increased intensity, and eventually arrives at the peculiar and original statement given between inverted commas in the first paragraph of his letter—a statement which he should not have any great difficulty in visibly substantiating to those who hold "the popular but entirely erroneous idea that red light is more penetrative than blue"—to quote his own vigorous prose.

Sol.

York, *October 8th*, 1906.

The Pentane Standard.

I was interested to note in your issue of September 28th, an account of the experiments which Mr. Dow has been making with the 10-candle Pentane lamp, and to see how closely many of his results agree with my own. I agree with him that owing to the rapid falling off in the candle-power of the lamp when burnt in a closed room it cannot be used for testing a constant source of light over long periods. The lamp, however, must be worked in the same way as electric standards by calibrating a comparison lamp against it—a process which requires only a few minutes. It will then give quite consistent results when corrected for humidity, &c., if readings be taken during the first 10 or 15 minutes after shutting down the ventilation of the photometer room, and about half an hour be allowed, after lighting up, for the lamp to attain a constant temperature. I do not think, as Mr. Dow suggests, that the falling off in candle-power can be described as due to "a deficiency of oxygen supplied to the burner," else one would expect the flame to smoke, but the cause should, perhaps, be looked for in a larger proportion of inert gas, chiefly nitrogen, which has to be heated up, for each volume of oxygen supplied.

As regards the correct point to take as the centre of illumination of the flame, which Mr. Dow discusses, there can surely be no comparison between the one-candle flame which Liebenthal investigated, and that of the 10 candle lamp. This one candle lamp has a solid flame with a screen in front allowing a portion only of the luminous part of the flame to be visible, and the incomplete screening for which Liebenthal's correction is applied occurs both at the top and bottom of the flame. On the other hand, in the 10-candle flame, which is hollow, there is no screening at the bottom, and the lower portion of the flame is non-luminous. Moreover, any screening effect caused by the chimney at the top can only be slight, owing to the smaller relative luminosity and diameter of this portion of the flame. The correction for inefficient screening, therefore, which Mr. Dow takes as 5 mm., becomes reduced to about 1 mm. in the case of the 10-candle lamp. By placing the photometer slightly above the centre of illumination, this can be still further reduced.

As regards the true centre of illumination of the flame, Mr. F. J. Selby has investigated the subject mathematically. Although the true centre cannot be determined precisely, calculations based on data assumed in order to obtain a superior limit, show that it will almost certainly not be more than 2 mm. from the geometrical axis, and most probably not more than 1 mm. In view of this, and as the universal practice both in this country and America is to take the geometrical axis as the centre, it seems unnecessary now to vary the practice. With a long flame of this type, it is, of course, very undesirable to use such a short distance as 400 mm. when accurate work is required.

The figures which Mr. Dow gives certainly show very large discrepancies,* but it should be noted that, if their cause is to be attributed to taking a wrong centre of illumination, then, in order to make his last reading at 350 mm. correct, this centre would have to be taken as lying 10 mm. from the geometrical axis, which would be on the front edge of the mean diameter of the flame.

It would be interesting to hear if Mr. Dow made tests to ascertain whether any personal error was introduced due to the change in illumination on his photometer screen, of from 10 to 80 candle meters; since, in view of the above facts, it would look as if some other factor must have entered into the measurements. I have not myself made many accurate tests on the pentane lamp to determine the variation of apparent candle-power at very short distances from the flame, but when I have had occasion to use shorter distances, even as low as 400 mm., I have never found differences of the order of magnitude as those mentioned in Mr. Dow's paper.

Clifford C. Paterson.

National Physical Laboratory,
October 2nd, 1906.

The Woolwich Appointment.

Your readers may remember the unbusinesslike procedure at Woolwich which was brought to light by a recent correspondence in the Electrical Review. Act I was rung down by the Town Clerk writing letters to the members of the short-list informing them that the advertisement was to be considered as cancelled. Act II commenced in the same week by the insertion of a box No. advertisement very similar to the original, but offering £250 instead of £200. No doubt the committee thought that they could get the right man by offering £50 more. A large number of candidates replied, and these were eventually short-listed to six. Now comes the comical side of the affair; the committee had evidently become duly impressed with their lapse from business etiquette in applying to the employers of the first unlucky six. Most likely they had a vague suspicion that the candidates had no employers at all. So a sub-committee of four was deputed to make a call on the candidates *at their places of business*, and what was the surprise of candidates and employers alike to receive visits from four worthy councillors, who invaded offices with bags and rugs and demanded to see the candidate for their electricity department's commercial vacancy. The peregrinations of these worthies extended as far as Swansea, and no doubt it was by the merest chance that they did not take a voyage to New Zealand. I said the affair was comical; but it also has its sad aspect. It shows that the persons who consider themselves fit to manage our affairs

* There would seem to be an error in the figures in the last line of the table, as the difference in this case is not quite in a line with those in the remainder of the table.

have absolutely no sense of business etiquette or fairness to the people who place themselves in their hands. It also shows a wanton disregard for economy, which is, unfortunately, nothing new. I hope the councillors enjoyed their change of air, and benefited by it more than the unsuccessful five candidates.

Ratepayer.

[We can hardly imagine any proceeding more utterly fatuous in its folly, or better calculated to prejudice the interests of the candidates whose employers were annoyed by this comic-opera house-to-house visitation; it is pitiable. —Eds. E.R.]

Twin Lead-covered Wiring.

Will you permit me through your columns to criticise Mr. E. L. Berry's new method of using the above system, and to explain for the benefit of your readers a simpler, cheaper and infinitely superior method of carrying out this system of wiring.

The system consists simply of looping the twin straight from one lighting point to the next, and using a three-contact ceiling rose for points controlled by one switch and a four-contact rose and three-wire flexible for points controlled by two switches. What can be simpler than such an arrangement? Why devise a special joint box when you can obtain an existing standard article which is superior both electrically and mechanically?

Twin lead-covered wiring should always be run on the surface in preference to being run under floors or plaster, but there is no objection to running it along the roof joists over the top floor of a house.

Where it is necessary to pass through walls or floors or to lay it in plaster or cement, it should be laid in single straight lengths of split tubing unscrewed and well covered after erection with tar or other cheap preservative. These lengths of tubes should be bushed, but need not be earthed if the lead sheathings are well earthed.

The joint box illustrated in your article is of a peculiarly objectionable design, owing to the primitive method of clamping the lead, the large number of terminals, badly designed porcelain base giving exceptionally small clearances and the number of these screw terminals. The terminals used necessitate twisting the strands of the wire round the terminal screws, which is not nearly so sound a job as inserting all the wires of the strand into a hollow terminal and clamping up with a set screw.

H. B. Maxwell,
Burgh Electrical Engineer.

Partick, *October 8th*, 1906.

Cost of Suction Gas Power.

This subject being one of great interest and importance to small power users, it seems a pity that the article which appeared in your number of the 21st ult. was ever published, being, as it was, utterly void of information, and as a criticism quite valueless. Mr. Tookey's reply in your issue of the 28th ult. was disappointing and unworthy of a man of his attainments. Why, in dealing with suction gas, drag in Jerome K. Jerome, King Charles's head and Æsop?

It was a relief to find Mr. Weaving's letter with detailed accounts of working costs, but on checking his figures I find his arithmetic seriously at fault. How is it that with a cost of ·97d. per unit he makes out that 20 B.H.P. cost 2·9d.? Surely with his figures 20 B.H.P. cost 2s. 2d. to 2s. 3d., and again, surely there is some mistake! And yet on looking up the works cost of current supplied by a gas-driven central station I find these figures approximately confirmed.

I have been given some figures concerning the actual cost of fuel and water used in a gas producer of the suction type, and these work out (over a period of six weeks) at ·0939d. per B.H.P.-hour, but they do not include labour, oil for engine, upkeep or interest and depreciation. It seems probable that the catch "10 to 20 B.H.P. for 1d." is based on bare fuel and water expenses.

Perhaps some other user of suction gas will be good enough to send you actual figures. This is the only way to convince power users as to the desirability or otherwise of putting down such plants. Generalities and makers' figures are worth nothing.

Junior.

[Our correspondent should note that the article in question was a reply to the unqualified claim that the suction gas system furnishes 20 B.H.P.-hours for 1d., a claim which he himself disputes. The arithmetical error which he notes was mentioned in our last issue.—Eds. E.R.]

The writer of the article calls on me to explain that which I thought was obvious—that 2·9d., given in my letter as the cost of 20 B.H.P.-hours, refers to fuel only, as did the phrase "20 B.H.P. at a penny an hour" in the article.

A unit certainly equals $1\frac{1}{3}$ B.H.P.-hours theoretically, but I have yet to find a dynamo of 100 per cent. efficiency.

R. Weaving.

Peterborough, *October 8th*, 1906.

We noted on page 474 of your September 21st issue a "Communicated" article on "Suction Gas Power," on page 482 of your issue an editorial notice entitled "Scarcity of Fuel for Suction Gas Plants," and on page 529 of your issue of October 5th a letter from a correspondent regarding the first-mentioned article and your footnote to this last.

We write to say that we are pleased to see this last communication, as we think it is high time attention was called to the persistency with which you insert remarks in your paper which in some way or another are attempts to bring this comparatively new form of power into disrepute.

If we had a complete set of your issues by us we could give many other instances of the unfair bias which you exhibit in this matter, but you are probably as well aware of your prejudices as we are.

We would point out to you what you are overlooking, viz., that if your view is to be of any value to your readers you must be able and willing to see more than one aspect of a question, and you must be prepared to concede that finality in the economical generation of power was not reached in 1900, and will not be reached in 2000 A.D.

With regard to the "communicated" article, we have not much doubt that at the first attempt we could tell who is responsible for it. We have read similar communications in other papers, in which similar extracts from Mr. Tookey's book have been used as an argument against the suction gas plant, and we need only say that it would have been fairer to your readers if the article had appeared over the name of the firm who is responsible for it, when its true value would have been apparent.

We have not time, nor do we think it necessary, to traverse the whole of the statements made in that article, especially as many of them have been dealt with by Mr. Hagues in your present issue. We might, however, add to Mr. Hagues's remarks that the question of spares for the gas plant is a bogey as every user knows, and with regard to the absence of the gasholder and the supply of gas, which, if a part of the plant, the holder would contain, there is nothing in this, as no gas-holder belonging to the average pressure plant contains sufficient gas to run the engine for more than, say, 15 to 20 minutes at the most.

We say confidently that when every expense in connection with the running of the gas plant installation has been taken into consideration, it is found in the majority of cases that there is no power so cheap at the present time except the forces of nature, such as wind and water. This statement does not hold good for special cases where power is only required intermittently for, say, an hour every day, and possibly or probably where it is required at a moment's notice, neither would a similar statement hold good under similar working conditions with a steam boiler. Where, however, anything approaching continuous running under ordinary workshop conditions is required, this statement is generally true for the size of units in which plants of this type are constructed at the present time.

With regard to the fuel question raised in your issue of September 28th, there are more coalfields in Great Britain from which anthracite can be obtained than that of South Wales, and with a view to informing you of this fact, and such of your readers as are interested, we have communicated

with Messrs. Wm. Baird & Co., Ltd., 168, West George Street, Glasgow, Messrs. James Nimmo & Co., Ltd., 21, Bothwell Street, Glasgow, and Messrs. James Waldie & Sons, 118, Queen Street, Glasgow, from all of which firms we have purchased anthracite for gas production from time to time, and have quotations from them for coal suitable for use in a suction gas plant, ranging in price from 23s. per ton upwards, delivered in London. We could give several other names if necessary.

Further than that, there is always gas coke to fall back on as a fuel, even if it is not used regularly in preference to anthracite.

Your footnote to the letter in your present issue states that "death by CO poisoning has occurred in connection with suction gas plant, and that explosions have been recorded." We should like to know how many fatal cases you can instance from the cause mentioned, and what proportion they bear to the fatalities arising from other sources of power. We have never heard of any cases of this kind.

With regard to explosions, whatever we have heard of in this direction has been something of small moment in which very little or no damage has been done either to person or property, and explosions, fires and fatal accidents are not altogether unknown in connection with electric power installations.

A man can be poisoned by fumes from a suction gas plant just as he can by fumes from a pressure gas plant or from the town main, though the likelihood of it is very much less in the suction plant than in either of the other cases. He can also be killed by electric shock and by falling off a bicycle, or out of a tree, or by falling down his own stairway; that, we think, no one will deny, but that there is such a constant and ever-impending risk of poisoning in connection with a properly designed and constructed plant, as the general trend of your writings would lead your readers to suppose, we do unhesitatingly deny, because it is the reverse of the truth.

The suction gas plant has a place to fill in the industrial world, which it can and does fill better than any other form of motive power, just as the steam engine and the electric motor have in their own particular spheres; and although your writings may stem the flow of the tide in its favour in the same way, and to the same extent, as the pebble on the beach, yet it will require something more than the obviously biased statements you constantly publish to have any permanent effect on its development.

The Campbell Gas Engine Co., Ltd.
HUGH CAMPBELL.

Halifax, *October 6th*, 1906.

[It is unfortunate that our correspondents have not a complete set of our issues at hand; if they had, they would be able to ascertain how groundless is their reiterated suggestion that we are prejudiced against the suction gas system. We have instituted a search extending as far back as the middle of last year, and find that out of the 19 articles, abstracts or leaderettes dealing with gas power within that period, 15 were either favourable to the gas engine or were purely technical articles or papers. Of the remaining four, one was a leaderette on anthracite coal, which was based on information coming to us direct from the Welsh coalfields; one was the "communicated" article, for the views in which we are not responsible; and the other two were editorials in which, nearly a year ago, we criticised the extravagant and misleading claims put forward on behalf of the suction gas system. Our attitude, which has not varied, is correctly summarised in the following extract from one of these (Vol. LVII, p. 831):—

"We have nothing to say against the suction gas plant, which, if installed to meet conditions to which it is suited, is, without doubt, an efficient and convenient means of generating motive power; but what we do most strongly condemn is the publication of figures which do not state the whole case and the careful suppression of others which would tend to neutralise their effect."

Of the 15 articles mentioned above, five related to the suction gas system, and were in no sense antagonistic to it. In April last year we described the suction gas-driven electricity works of Church Stretton, and spoke of the system as "an ideal installation for a small and purely residential district."

Our footnote to the letter in our last issue corrected misstatements; we publish reports of death by electric shock—are we to suppress facts relating to gas plant, in order to prove our impartiality? This is the kind of attitude adopted by the anti-patriotic party, which has unfortunately been so prominent of late years—nothing but praise for aliens, nothing but blame for our own people—but it is not our attitude.

The death by CO poisoning which we had in mind when penning the note was that of a man called Fogo, employed at the works of Messrs. Currie & Rowlands, Seacombe. The evidence at the inquest showed that he was poisoned by the gas.

How the "general trend" of our writings would lead our readers to suppose that there is great risk of poisoning we do not know, for the footnote in question is the only instance in which we have mentioned it editorially, so far as we are aware.

The "communicated" article was written by an engineer who has contributed to our columns for years; no "firm" whatever was responsible for it, and we cannot imagine what our correspondents have in their minds in making this most unjustified insinuation.

For a fair statement of the comparative cost of steam, gas and oil power, we may refer our readers to the address given to the Civil and Mechanical Engineers' Society by Mr. W. B. Esson, and reported elsewhere in this issue.

As we have shown, and as our readers are aware, we have never assumed a hostile attitude towards the suction gas system; our quarrel is only with the extravagant figures put forward on its behalf by its advocates, figures which our correspondents do not attempt to justify.—EDS. E.R.]

INFORMATION WANTED.—Can any of your readers inform us where we could obtain a small motor-car type of engine to run with paraffin, suitable for direct coupling to dynamo?—ENQUIRERS.

We should be glad to know the address of makers of the machinery used in the manufacture of incandescent electric lamps.—E.

ELECTRICITY SUPPLY IN BIRMINGHAM.

THE history of electricity supply in Birmingham commences in the year 1882, when the Incandescent Electric Lighting Co., Ltd., obtained a provisional order for the lighting of a portion of the city. The engineers to the company were Mr. R. E. Crompton and Mr. Henry Lee; they installed a small plant in the neighbourhood of Paradise Street for supplying the Town Hall and some adjoining buildings, but in 1886 the company ceased to exist owing to the Board of Trade cancelling its order.

The next effort at electric lighting occurred in the year 1889, when Messrs. Chamberlain & Hookham obtained a prov. order.

This was eventually purchased by Messrs. Holmes and Vaudrey, of Liverpool, who, late in the year, formed the Birmingham Electric Supply Co., Ltd., to work the order, Mr. J. C. Vaudrey being the engineer and managing director.

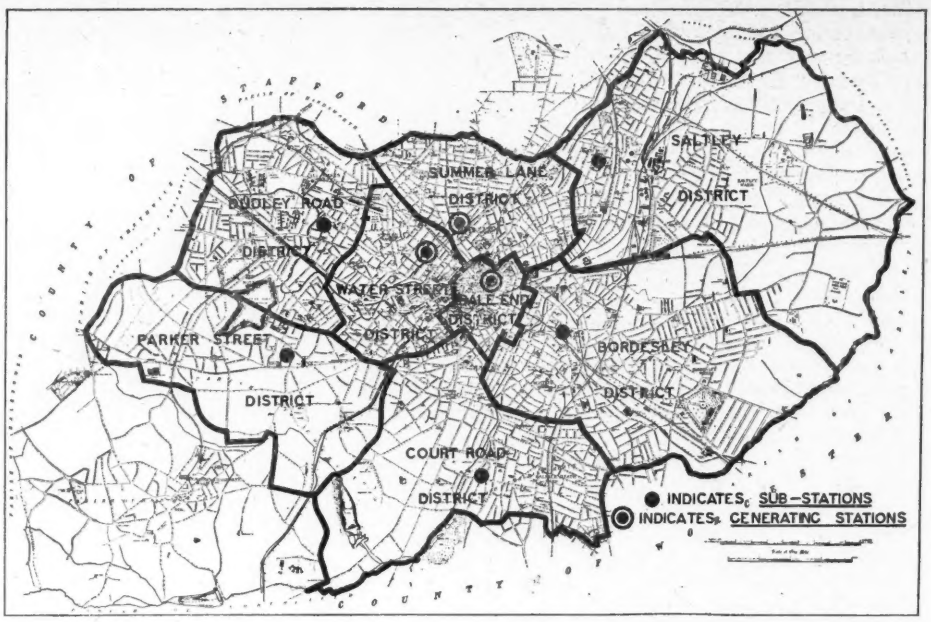
The company acquired a site in Dale End, close to the centre of the city, and there constructed a generating station and offices; a second generating station was built in Water Street in the year 1896, and in the same year a sub-station was erected in Edgbaston for giving a supply to that residential district.

The whole of the above undertaking was purchased by the Corporation of Birmingham in the year 1900, and a municipal supply established, with Mr. J. C. Vaudrey as city electrical engineer. The plant installed at Dale End is, of course, of an early pattern, consisting mostly of small units. It includes six Willans & Robinson compound engines direct coupled to 120-KW. Crompton D.C. generators; three engines by the same makers coupled to 160-KW. Crompton D.C. generators; and two Belliss & Morcom compound engines coupled to E.C.C. 160-KW. D.C. generators, the total capacity amounting to some 1,500 KW. The boiler plant includes six Lancashire type boilers, each 28 ft. × 7 ft. 6 in. diam., supplied by S. Danks & Co., Ltd., and four Babcock

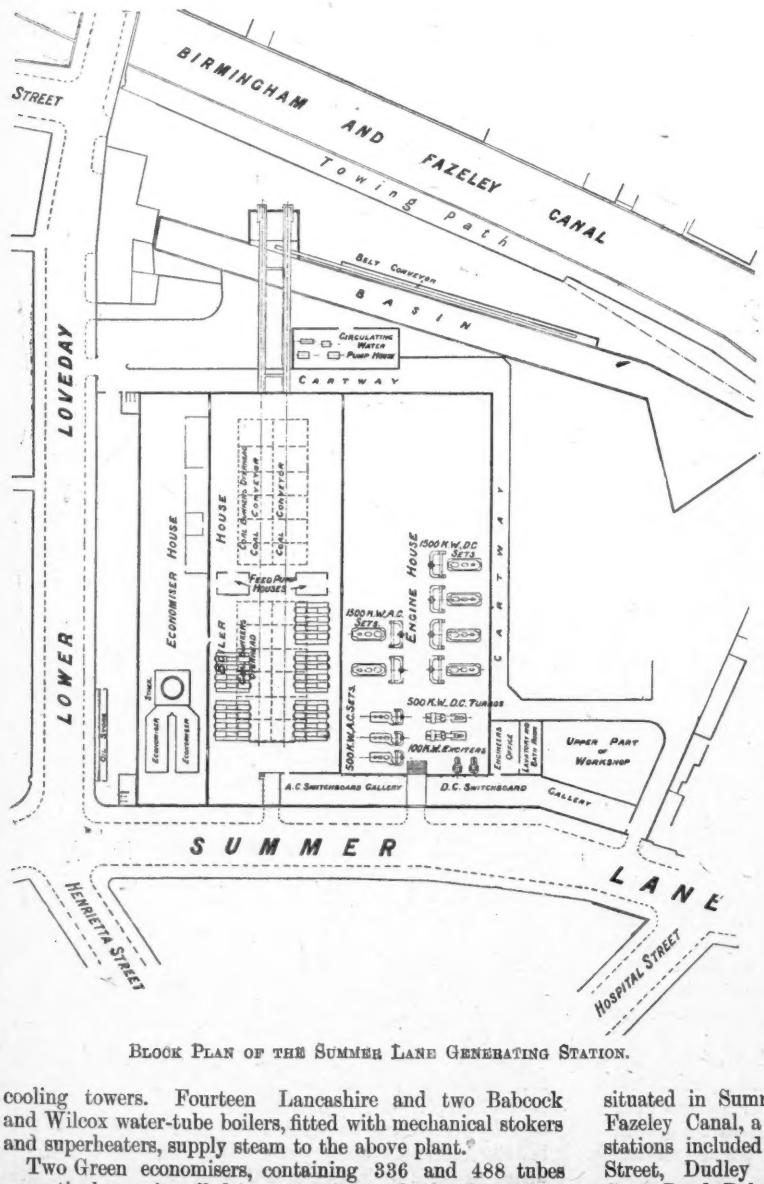
and Wilcox water-tube boilers. This station is non-condensing.

The Water Street station contains the following generating plant:—Seven Belliss and Morcom compound engines direct coupled to four Crompton and three E.C.C. 208-KW. D.C. generators; four Willans & Robinson compound engines coupled to 500-KW. Mather & Platt D.C. generators, the total capacity of the generating plant being 3,456 KW. The four larger units are worked in conjunction with two surface condensers, for which the circulating water is cooled in two fan-draught Barnard cooling towers. Fourteen Lancashire and two Babcock and Wilcox water-tube boilers, fitted with mechanical stokers and superheaters, supply steam to the above plant.

Two Green economisers, containing 336 and 488 tubes respectively, are installed in connection with the Lancashire boilers. For the supply of the outer districts, three 120-KW., and two 60-KW. 240/1,200-volt E.C.C. step-up motor transformers were also installed.



Plan of the Birmingham Area, Showing the Electrical Sub-Division of the City.



Block Plan of the Summer Lane Generating Station.

The system of supply originally consisted of a two-wire distribution at a pressure of 110 volts, but this was gradually displaced in favour of a three-wire system, with a pressure across the outers of 220 volts.

The latter in turn (about the year 1899) gave place to higher pressures, the voltage being increased to 440 across the outers, when 220-volt lamps were introduced.

On the resignation of Mr. Vaudrey in 1903, Mr. R. A. Chattock, who had for some years previously acted in a similar capacity in connection with the Bradford electrical undertaking, was appointed city electrical engineer, and his appointment synchronised with the Corporation's decision to municipalise the city tramways and to convert them to the overhead system of electric traction.

In order to carry out this very desirable project, and further to place the city in a position to adequately meet the growing needs of its many industries for energy for both power and lighting purposes, the Electric Supply Committee decided on a comprehensive scheme, involving the erection of a large generating station for the supply of both direct and alternating current, the latter being transmitted to a series of sub-stations, at high pressure, and from there distributed locally as direct current.

The Corporation placed the whole of the work in connection with this large scheme of extensions in the hands of Mr. Chattock, the capital outlay involved being approximately £500,000.

The Corporation's new station is situated in Summer Lane, adjoining the Birmingham and Fazeley Canal, a comparatively central position. The sub-stations included in the scheme are situated in Camden Street, Dudley Road; Upper Trinity Street, Bordesley; Court Road, Balsall; and Scholefield Street, Saltley.

The accompanying map indicates the relative positions of the various generating and sub-stations, which, as we shall fully describe and illustrate them in a later issue, will be briefly referred to here.

The station has been laid out to give several classes of supply.

1. A direct current supply for private lighting and power purposes, in the neighbourhood of the station, at pressures of 220 and 440 volts.

2. A direct current supply, through a system of trunk mains, to the distributing switchboards at Dale End and Water Street generating stations at a pressure of 440 volts, in order to deal with the increase in the demand for private lighting and power supply in these districts.

3. A direct current supply to the electric tramways within a radius of about two miles from the generating station, at a pressure of 550 volts.

4. An extra high tension three-phase alternating current supply to the sub-stations which have been erected in the out-lying districts of the city, at a pressure of 5,000 volts.

The new station consists of an engine room 275 ft. long × 100 ft. span, a boiler house 275 ft. long × 89 ft. span, and an economiser house 275 ft. long × 47 ft. span.

A separate building, 71 ft. long × 24 ft. span, accommodates the centrifugal pumping plant for supplying the circulating water to the condensers.

Accommodation is also provided for offices, stores, repair workshop, and storage battery room.

In the engine room the direct-current plant is installed on one side of the building and the high-tension alternating-current plant on the other side, the switchboards controlling each class of supply being also kept distinct in the same manner.

The plant for which accommodation has been provided is as follows :—

Description.	First equipment.	Ultimate capacity.
In engine house:—		
D.C. engines and generators ...	7,000 KW.	13,000 KW.
A.C. engines and generators ...	4,500 KW.	13,500 KW.

The D.C. engines and generators consist of four Belliss and Morcom medium-speed enclosed engines, coupled to generators built by Messrs. Dick, Kerr & Co., Ltd., each having a full load capacity of 1,500 KW. and an overload capacity of 25 per cent. in excess of this.

These generators are compound-wound direct-current machines, and can be used for tramway supply or as shunt machines for lighting supply.

Two Parsons steam turbo-generators, each having a capacity of 500 KW. at full load, have also been installed.

The A.C. engines and generators consist of two Belliss and Morcom triple-expansion medium-speed engines of 1,500 KW. capacity each, and three similar type engines of 500 KW. capacity each.

The A.C. generators are by the British Westinghouse Electric and Manufacturing Co., Ltd., and have rotating fields and fixed armatures. Each of these sets has an overload capacity of 25 per cent. in excess of the normal full load.

The current for energising the fields is supplied by two 100-KW. direct-current generators, built by the General Electric Co., Ltd., and coupled to compound engines built by Messrs. Belliss & Morcom, Ltd.

Two 110-KW. motor-driven balancers, two 25-KW. motor-driven boosters for boosting the trunk feeders, and a 200-KW. motor-generator for tramway purposes, all of the Phœnix Dynamo Manufacturing Co.'s make, are also installed.

A rotary converter and a large storage battery will be added in the near future. The engine room is spanned by a Jessop & Appleby four-motor travelling crane, arranged for lifting either 40 tons or 10 tons on a second lift.

The switchboards for controlling the generators are installed on galleries at one end of the building, and have been supplied by the British Thomson-Houston Co. On the direct current side, the generator switch-gear and the traction and trunk boards are arranged on the first gallery ; the local lighting switch-gear is installed on the top gallery.

On the alternating side, the generators are controlled from a bench board facing the machines ; three distinct group feeder bus-bars are provided, one for lighting, power, &c., one for traction, and one to act as a spare.

The generator leads are housed in three tunnels running under the centre of the engine room, and the feeders pass out behind the main switchboard.

In the boiler house will be provided, as a first equipment, 10 Babcock & Wilcock water-tube boilers, capable of evaporating 240,000 lb. of water per hour, and four Weir feed pumps, each with a capacity of 8,000 gallons per hour. Ultimatety, 24 such boilers and 12 feed pumps will be installed.

The coaling arrangements for the plant are most complete. Normally coal is brought to the station in barges and conveyed to bunkers situated over the boiler house ; from the bunkers the coal is fed by gravity into the stoker hoppers in the usual way. The ashes are also removed by the conveyors.

An economiser house, containing four Green economisers, with a total of 1,280 tubes, is situated on one side of the boiler house.

The condensing plant throughout the station is of the surface type ; circulating water is pumped from the canal by means of one 12-in. and two 20-in. centrifugal pumps, the return water re-entering the canal at a point one-third mile distant.

The sub-station equipment was supplied by the British Westinghouse Electric and Manufacturing Co. It consists of 300 KW. rotary converters fed through banks of single-phase transformers, with the necessary alternating and direct-current switchgear arranged on opposite galleries, facing the machines. Storage batteries are provided on an upper floor, the charging boosters being installed on the ground floor.

The cable network in the city includes 117 miles of lighting feeders and distributors, 32 miles of traction feeders, 24 miles of E.H.T. cables, and 30 miles of telephone and pilot wire.

Opening of the Summer Lane Station, Oct. 10th, 1906.

The new station was formally inaugurated by the Lord Mayor of Birmingham, Councillor A. J. Reynolds, J.P., in the presence of a large and thoroughly representative attendance of the public and official life of the city.

After inspecting the station and its equipment, the company was entertained to tea by Councillor Ellaway ; subsequently the Lord Mayor declared the building open. The electric supply department was, he said, one of the four important commercial undertakings of the Corporation, and he believed it would prove a valuable asset to the city.

Councillor Ellaway, chairman of the Electric Supply Committee, who thanked the Lord Mayor for performing the opening ceremony, observed that the Electric Supply Committee were now only able to give the visitors an inadequate idea of what the station would ultimately comprise. Its equipment, although by the end of this year it would exceed 22,000 H.P., was not one-half of what they hoped would be needed in a few years' time. The responsibility for the whole of the work had been borne by their engineer, Mr. Chattock, who had planned and carried it out in all its details. In regard to the development of the department, if anyone thought that its progress might have been more rapid had they built the station six years ago, when they bought the site, the answer was a simple one, they had deliberately held back until such time as they saw the prospect of a tramway load. As it was, they had made the most of their resources elsewhere, they were assured of one large customer in the tramways, which would probably require at once seven to eight million units per annum, a figure which would be largely increased as new lines were opened up, and the 1911 leases fell in. One customer was, however, even more necessary than the tramways, *i.e.*, the manufacturer who took current for power or lighting purposes in the daytime. With a view to the development of a heavy day load, the department had recently introduced the system of motor hiring.

Alderman Clayton, who formally opened, when Mayor of Birmingham, the Dale End electric station, referred to that station as a very small affair, and he supposed on such an occasion as the present they would regard him as a relic of the past.

The Lord Mayor briefly responded, and the proceedings terminated.

THE ENGINEERING AND MACHINERY EXHIBITION AT OLYMPIA.

(*Concluded from page* 535.)

Hyatt Roller Bearing Co.

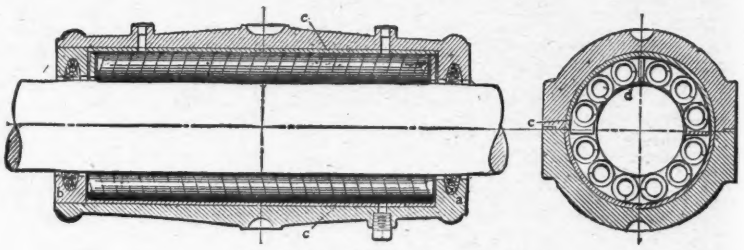
The essential feature of the Hyatt roller bearing is the flexible type of roller adopted; this it is claimed offers a cheaper and more efficient construction than in the case of solid roller bearings, where the rollers, linings and sleeves must be hardened and ground up with the greatest care in order to ensure satisfactory operation.

The Hyatt type of roller consists of essentially a spring and is made by winding a steel strip of special composition into a roller, and varying the dimensions of the strip, depending upon the conditions of speed and load under which the roller is to operate. It will be readily seen that such a roller has the element of flexibility.

This flexibility permits absolutely uniform distribution of load along the entire length of the roller, or, in other words, we have a full line of contact as compared with a series of points in the case of a ball or greater number of points in the case of a solid roller. It has been found in practice to be feasible to eliminate hardened and ground surfaces, and except in cases of iron surfaces, no sleeves or linings are required, and even in such instances steel sleeves of a very simple character and at a very low cost can be provided.

It will also be noted from the construction of this roller that it acts essentially as an oil reservoir and its spiral formation acts as an oil carrier promoting efficient lubrication.

The bearing has been adapted to various classes of work, a drawing which we have before us showing a bearing for the 5-in. journal of a 20-ton coal wagon for the N.E. Railway Co. Our illustration shows its adaptation to a bearing of the swivel type.



The Hyatt Roller Bearing.

Geo. Richards & Co., Ltd.

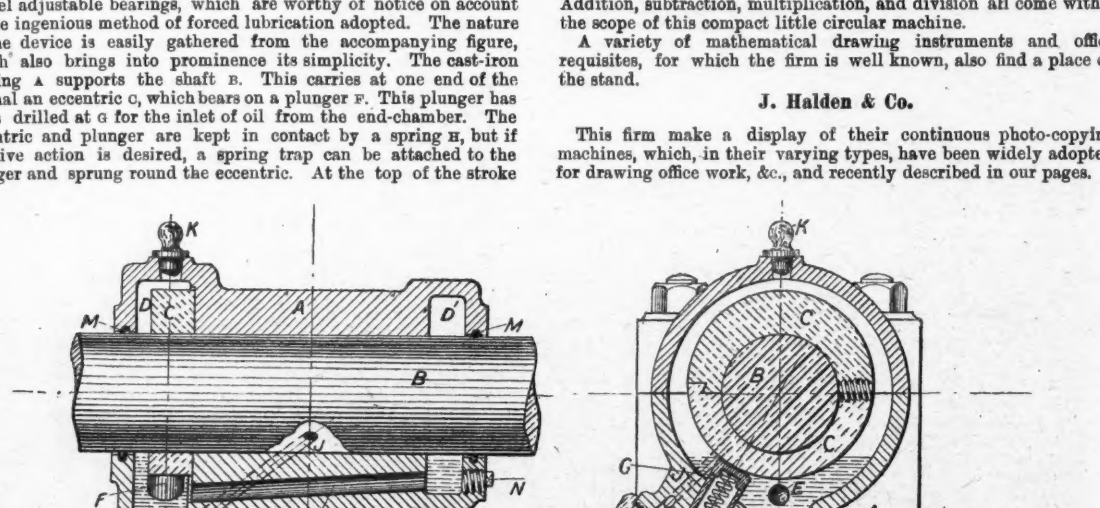
On this stand is a short length of line shafting running in two swivel adjustable bearings, which are worthy of notice on account of the ingenious method of forced lubrication adopted. The nature of the device is easily gathered from the accompanying figure, which also brings into prominence its simplicity. The cast-iron bearing A supports the shaft B. This carries at one end of the journal an eccentric C, which bears on a plunger F. This plunger has holes drilled at G for the inlet of oil from the end-chamber. The eccentric and plunger are kept in contact by a spring H, but if positive action is desired, a spring trap can be attached to the plunger and sprung round the eccentric. At the top of the stroke the plunger allows oil to pass into its interior by way of the holes G; the movement of the plunger cuts off the oil supply, and the contained lubricant is forced past the non-return valve I and through the outlet J, to the shaft. It is obvious that the quantity of oil delivered can be regulated according to the height of the holes in the plunger, and it will also be seen that the oil can be sent direct to the part of the bearing under the greatest pressure. Sufficient oil is poured through the oil feed K to last several months, and it returns by way of the end chambers, to be pumped up over and over again.

To keep the oil from running along the shaft, two grooves M are turned in the ends of the bearing, say ¼ in. wide and ¼ in. deep. In these grooves are placed leather washers for which an old belt may be conveniently cut up and fitted in place. These washers not only retain the oil in the bearing, but absolutely keep out all dust and dirt. Half-way between the outlet of the oil, and the inlet to the shaft in one of the bearings on view, a pressure gauge is fixed which shows a pressure of 15 lb., which pressure is required to lift the shaft to ensure its running on a film of oil.

The advantages claimed by the licensors of the system are enormous. There can be no doubt of the value of forced lubrication for minimising friction and preventing wear.

With forced lubrication, brass and white metal bushes are dispensed with, and the licensors also claim that with the adoption of the leather washers M, the oil can be used over and over again for twelve months without any loss, and however bad the conditions are under which the bearings are working, no dirt or grit can get to the oil.

Messrs. Richards & Co, Ltd., of Broadheath, apply this system to the bearings of line-shafting, air compressors, and machine tools, and to work under licence.



Forced Lubrication Co.'s Patent Bearing, shown by Messrs. G. Richards & Co.

John Davis & Son, Ltd.

Messrs. Davis's exhibit should claim the attention of all large employers of labour, if only by reason of the various mechanical calculators on view. Of these the Smith-Davis piece-work balance calculator is probably the best known; it enables the proportion of the total balance money due individually to any number of men sharing profits on the same contract, to be quickly found, the divisions being proportional to each man's fixed daily or weekly money rate.

The "Gauss" calculator, however, is the latest device of this class, a machine shown by the firm being designed for the computation of all calculations whose products do not exceed ten figures. Addition, subtraction, multiplication, and division all come within the scope of this compact little circular machine.

A variety of mathematical drawing instruments and office requisites, for which the firm is well known, also find a place on the stand.

J. Halden & Co.

This firm make a display of their continuous photo-copying machines, which, in their varying types, have been widely adopted for drawing office work, &c., and recently described in our pages.

Electrically-operated Bulkhead Doors.—We are informed that a contract was signed on 5th inst. by the London representatives of the Spanish Royal Naval Commission here and the "Long-Arm" System Co., for the installation of 19 electrically-operated bulkhead doors for the Spanish cruiser *Reina Regente*, now building at the Port of Ferrol. The Spanish naval authorities, actively supported by King Alfonso, are proceeding vigorously with the rebuilding of Spain's Navy, and the utmost efforts are been made to ensure that the new ships shall be up-to-date in every way. The system of electrical power doors adopted by the Spanish Navy is the same as that in use on nearly all the new vessels of the United States Navy. It enables closure of the main bulkhead doors to be effected from an electrical central station located on the bridge.

BUSINESS NOTES.

Indian Trade in 1905-6.—The Review of the Trade of India during the year ended March 31st, 1906, recently published by the Indian Government, states that the continuous growth in the importation of machinery is one of the most healthy features of Indian trade, and had been remarkable in the year 1905-6. In the three years, before the cycle of bad seasons arrested the economic growth of the country, the figures were as follows:—1894-5, 244·24 lakhs; 1895-6, 323·74 lakhs; 1896-7, 350·9 lakhs. This last figure remained the record until 1904-5, when 402·7 lakhs was attained. In 1905-6 this has been exceeded by no less than 22·2 per cent., which brings the total value to 491·97 lakhs, the net increase being 89·24 lakhs. The year has been exceptional, more especially in respect of the great activity in the textile industries; although the installation of new cotton and jute plant is proceeding actively, it is doubtful whether the same rate of progress can be maintained in the current year. Bengal imported machinery to the value of 236 lakhs, which is 20 per cent. above the figure for 1904-5. Almost the whole of this increase of 40·27 lakhs is accounted for by the increase from 94·25 lakhs to nearly 125 lakhs in jute machinery, while in Bombay the increase is due to additions to plant in cotton mills. In Bombay the increase has exceeded that in Bengal, and amounts to 54·5 lakhs, or 44·9 per cent. The extent to which the extraordinary activity of the year was confined to the two main textile industries is emphasised by the fact that in the provinces other than Bengal and Bombay the value of machinery imported actually decreased 6·4 per cent. The totals of the various classes of machinery imported into all India were as follows:—

Steam engines and parts	Rs. 1.02.82.000
Textile...	2.46.32.000
Electrical	23.06.000
Mining...	5.91.000
Other descriptions	1.13.86.000

Rupee = 1s. 4d., or Rs. 15 = £1.

Belgian Enterprise at Beyrout. — The Société Anonyme Ottomane des Tramways et de l'Electricité de Beyrouth is the title of a Belgo-Turkish enterprise which has been established at Constantinople with an authorised ordinary share capital of £240,000, of which £144,000 has already been paid up, and 3,800 founder shares have also been created. Apart from Turkish interests the Belgian financial circles are represented on the administrative council by M. Victor Limauge, president of the France-Belgian Tramway and Electricity Trust, of Brussels; M. A. Laloux, president of the Liége Bank; M. C. Thonet, general director of the Société l'Enterprise Générale de Travaux, of Liége; M. E. Denis, tramway administrator; and M. I. Fernandez, of the Banque de Salonique, of Constantinople. The company has been constituted to take over the concession granted by the Turkish Government to his Excellency Sélim Raad Effendi, who is a member of the council of administration, for the construction and working of electric tramways and steam or water power generating station at Beyrout, which ranks as the first port and the most important commercial place in Syria, and the supply of light and power in the city. The obligatory network of tramways, which will be equipped on the overhead trolley system, comprises a length of 7·4 miles, and in order to carry out this work and to acquire the concession the sum of £144,000 has already been subscribed by the Belgian interests already mentioned and his Excellency Nedjib Pacha Melhamé, who has assumed the position of president of the company. The concession, which also carries with it the right to establish other tramways, is for a period of 99 years, and it confers upon the company preferential rights in regard to the granting of concessions for transport purposes by means of automobiles and for the institution of a telephone service. After defraying working expenses, paying interest on and redeeming obligations (there are no bonds at present), and distributing 6 per cent. dividend to the shareholders, 12 per cent. of the balance is to be paid to the Turkish Government in favour of the Hedjaz railway.

American Exports of Electrical Machinery.—A recent publication of the Department of Commerce and Labour of the United States contains an interesting monograph under the heading "Machinery, Increase in Exports, Persistent Rivalry for Markets of the World, United States makes the best, Great Britain sells the most, Instructive comparisons." Under the sub-heading "Electrical and Mining Machinery" will be found these remarks: "Our exports of electrical machinery in 1904 were threefold those from the United Kingdom—$7,409,200, and $2,545,200 respectively. Our largest exports were to Canada ($2,023,900), Japan ($1,239,900), and Mexico ($1,037,300). This not only shows the advanced position of the development of these three countries, but it shows that the trend of all countries eager to develop their industrial resources is toward the employment of electrical machinery. Unless some power superior to electrical energy should supervene, electric machinery and electric appliances of all kinds will dominate the industrial future. It, therefore, only remains for American electricians to cater for the world's requirements to hold the lead they have already won in this great branch of the machine industry. When the amount of electric machinery in use in the United States is taken into consideration, if such were possible of conception, that we should have an export thereof valued at $7,409,200 in 1904, is really wonderful, and that the United Kingdom should be our third largest consumer thereof, shows that our greatest markets are in the most advanced countries, these only being capable of handling this new power and reducing it to the industrial uses."

This may certainly be a very glowing statement of the case, but there is a great underlying truth. If British manufacturers have mastered the art of producing electrical machinery, they have certainly failed to a great extent in mastering the art of putting their products on to the world's markets as successfully as the Americans. Recent articles in the Electrical Review on the subject of the "Neutral Markets of the World" have all gone to show how speedily American manufacturers have grasped the fact that there is a tremendous future before the electrical industry in these markets, which may be said to be only in their infancy as industrial countries. In the case of the several South and Central American States the success of the United States may have been due to proximity of position; but the fact that German manufacturers have succeeded in gaining a great trade in these States is proof that this proximity of position is not the only factor in securing the trade. Both Germans and Americans have discovered the truth of the statement that trade follows investment of capital, and there can be little doubt but that it has been this investment of capital in the new undertakings of the neutral markets which has led to the great trade held by these two countries. In those countries, particularly where coal is scarce and water-power plentiful, the advance of industry, both manufacturing and mining, is solely dependent on electric energy. The tariffs of the several neutral markets are being constantly raised with a view to the artificial expansion of the home industries. In many cases these two conditions, viz., shortage of coal supply and increasing tariffs, prevail in the same country, add to this that water power is abundant, and it is apparent that this expansion of industry on which the Governments seem to be intent, must bring with it, as well as be dependent on, a large importation of electrical machinery and appliances. Apart from this, new towns are being opened up, old towns are being improved, electric tramways, railways, lighting, as well as telephonic and telegraphic communications are being installed everywhere, and yet in this one trade which has probably a more promising future than any other trade extant, British capitalists and manufacturers are allowing Americans and Germans to gain this great foothold, which once gained they will not relinquish without a struggle.

The following statement taken from the official trade statistics of the United Kingdom and the United States, shows the relative positions of these two countries as regards their exports of electrical machinery; the details given for the United States refer to the year ended June 30th, 1905, and those for the United Kingdom to the year 1905:—

	United States.	United Kingdom.
Total exports	£1,518,944	£644,480
Exports to United Kingdom ...	226,867	—
" " Canada	354,897	2,489
" " Japan	289,974	73,025
" " Mexico	192,722	7,217
" " South Africa ...	23,926	112,728

Annual Dinner.—The second annual dinner of the British Empire Motor Trades Alliance, Ltd., will be held at the Hotel Russell, Russell Square, London, W.C., on Monday, December 3rd next.

Bankruptcy Proceedings.—Chas. Chadwell.—At the Blackburn County Court, on 3rd inst., Charles Chadwell, civil engineer, of Richmond Terrace, Blackburn, underwent his public examination. He attributed his failure to losses in business, his statement of affairs showing gross liabilities, £27,524 (of which £25,207 was expected to rank for dividend), and assets estimated at £2,712. In reply to the Official Receiver (Mr. Plant), the debtor said he began business about 1889 without capital. Of his many large contracts since that time some had paid; others had been unprofitable. He was contractor for the Blackpool, St. Anne's and Lytham tramway, the amount of that contract being (for the whole of the work) £104,000. He was perfectly solvent at the time he undertook it. The Official Receiver asked if some of the unsecured liabilities were not in respect of that contract? The debtor: Certainly; I received £74,000 in cash, and the balance in shares. There was a verbal agreement that I should afterwards receive cash for those shares, from the underwriter, but I did not get it. I did not take the precaution of seeing what the capital of the company was, and when I had completed the line, the company at once reduced its capital, and my shares were worthless. The loss on those shares represents practically a money loss. Replying to further questions, the debtor said the present liabilities in respect of that contract were about £25,000. He paid over the £74,000 received in cash to the sub-contractor. The Official Receiver: And he made a profit of £13,000. You had no consideration at all for these shares? The debtor: None; they were handed over to the trustee under the deed of assignment. Three blocks of shares were given to people who had signed the deed of assignment, and several of the larger creditors of the tramway were handed some of the shares as security for their debts. Speaking from memory, the trustee had £16,000 worth; the rest were divided amongst creditors. I received about £10,000 credit for that £16,000. The Official Receiver: Then if you add that £10,000 to the £25,000 owing, there will be £35,000 owing upon the contract at the date of assignment? The debtor: No; because the shares were given as security for debt. They did not take it off the account; they merely held it as security. Replying to further questions, the debtor said that two years ago he assigned all his assets to Mr. Blakemoor, of London, and the value, if everything had been carried on as it should have been, would, he believed, give a surplus of £30,000. The Registrar remarked that the unsecured liabilities, at the same date, were returned at over £30,000. The debtor said

he had shares in three or four tramways, in respect of which provisional orders had been obtained, and if he had been able at the time of the assignment to negotiate these he would have been able to pay 20s. in the pound. It was pointed out that the trustee on the assignment declared no dividend, but the debtor adhered to his opinion that had the assets been properly negotiated he would have been able to pay his creditors in full. He did not blame the trustee, but suggested that some creditors had not done their duty. As to his means of livelihood since the assignment the debtor said he had been doing professional work. He had had no profits, but had borrowed money. The Official Receiver: Since the deed of assignment you have contracted further debts—something like £1,000? The debtor: Yes; but I have been working on one of these contracts, and have received moneys for my work. The examination was adjourned.

C. H. Hegley.—The public examination of Mr. Charles Hubert Hegley, electrical engineer, formerly of Gun Lane, Strood, but now of 33, Weston Road, Strood, Rochester, took place on Monday, 8th inst., before Mr. Registrar Smith at the Rochester Bankruptcy Court. The gross liabilities are £267, all of which is unsecured. He has carried on business since 1894 as an electrical engineer and millwright, until last February, when he sold his business to Mr. H. F. A. Greenland, of Rochester, for £125, and he is now employed by him as manager. He has given a bill of sale on his household effects to his brother, Mr. Hegley, of Chatham, from whom he has borrowed money from time to time. The debtor has been sued for some considerable time past (since 1905) in the County Courts, and has been insolvent for some time, but he thought when he sold his business he would be able to satisfy his creditors. There was no opposition, and debtor was allowed to pass.

R. O. Thompson.—At Brighton Bankruptcy Court on October 4th, Robert Owen Thompson, electrical engineer, 30A, Dorset Gardens, Brighton, was examined on accounts showing liabilities amounting to £510 17s., and assets £74. Debtor stated that he took over the business from his father, who was 80 years of age, without any payment, and from that time his father worked for him. He only took 30s. per week out of the business for himself, and gave his father 25s. or 30s. per week. Business had been very bad during the past year. The examination was closed.

Albert Dickinson, electrical engineer, Wortley, Leeds. October 26th is the last date for sending in proofs for intended dividend in this case to Mr. J. Bowling, the trustee, 22, Park Row, Leeds.

Germany.—The Deutsche Edison-Lalande Elementbaufabrik "Delef" Gesellschaft is the name of a company which has just been formed in Berlin with a capital of £4,000 to manufacture Edison-Lalande batteries in accordance with the Wiechmann patents.

Milan Exhibition Awards.—The Simplex Conduits, Ltd., of Birmingham, have been awarded two gold medals at the above exhibition, one for the marine section, and one for the land section; also two silver collaborateur medals, and one bronze medal.

Goods and Parcels Tariffs.—Messrs. Neale and Wilkinson, Ltd., of 32, St. Mary Axe, E.C., have issued a pamphlet giving full particulars of their new A.B.C. tariff of rates for the conveyance of goods and parcels to all parts of the world. The information is set out in a convenient form for easy reference and is revised right up to date. Anyone in the electrical trade needing matter of this kind at hand in the conduct of their businesses—and who does not? some all the time, and the rest at some time or other—should write for a copy of this publication.

Condensing Plants.—The Mirrlees Watson Co., Ltd., of Glasgow, have just received the following important orders for condensing plant:—

Central London Railway Co.—One barometric jet condensing plant, duty 62,000 lb.
Guest, Keen and Nettlefolds, Ltd.—One surface condensing plant, duty 50,000 lb.
Liverpool Corporation (per The British Thomson-Houston Co.).—Three subbase surface condensing plants, duty each 35,200 lb.
Adelaide Electricity Supply Co.—One dry air pump, duty 15,000 lb.
G. Harland, Bowden & Co.—One surface condensing plant, duty 20,000 lb.
Bournemouth & Poole Electric Supply Co., Ltd.—Two Mirrlees-Edwards electrically driven air pumps.

H.B. Lifeguards.—Messrs. Hudson & Bowring, Ltd., have received the following orders for their patent lifeguard:—

34 sets for the London County Council subway cars.
10 sets for the Carthagene cars.
20 sets for the Bombay cars.
Further orders for Wolverhampton, Jarrow, Bury and Rangoon.

This form of lifeguard has also been fitted on royalty to the Salford and Johannesburg cars.

Rolling Stock in Italy.—The Italian Southern Railway Co., which is ceasing the operative part of railway business owing to the transfer of the lines to the State, proposes to embark upon the construction of railway material, and especially that intended for electric railways. With this object in view, negotiations have been entered upon with the locomotive and wagon building company of Ernesto Breda, of Sesto S. Giovanni, near Milan. The scheme is to be carried into effect by the latter increasing its share capital from £320,000 to £800,000, and both the railway company and the Italian Commercial Bank will participate in the fresh issue. In addition to enlarging the workshops at Sesto S. Giovanni, and undertaking the construction of electric locomotives and motor-cars, the company intend to establish a branch at Naples in order to be able to enjoy the advantages which the Government grants to new industries introduced at that port. Apart from this scheme there is a second project of a similar character which centres around the firm of Gadda & Co., which is said to be the largest producer of electrical machinery in Italy, and which is also to engage in the output of electric railway rolling stock. This particular project has been coupled with the name of the Allgemeine Elektricitäts Gesellschaft, of Berlin, but the latter contradicts the statement that it is in negotiation with the object of taking over an Italian concern, or founding a subsidiary undertaking in that country. As a matter of fact, the Berlin A.E.G. is not in a position to establish such a concern as it already has one in the form of the A.E.G. Thomson-Houston Società Elettricita Italina. This company originated, on the conclusion of the relations with the Thomson-Houston Co. a long time ago, from the amalgamation of the Italian branches of both companies.

Book Notices.—"Bulletin of the Bureau of Standards," Vol. 2, No. 2, August, 1906. Washington, U.S.A.: Department of Commerce and Labour.

The Indicator Handbook. By C. N. Pickworth, Wh. Sch. Manchester: Emmott & Co. Price 3s. net.—This is the third edition of the author's work on the indicator diagram, now forming Part II of the Handbook, and is really too well known and appreciated to need commendation. The present issue has been revised, and a table of the properties of saturated steam has been added. Steam, gas and oil engines, air compressors, pumps, &c., are dealt with in minute detail, and there are few, if any, peculiarities in diagrams which cannot be explained with the aid of this excellent guide.

English Weights with their Equivalents in Kilogrammes. By F. W. A. Logan. London: E. and F. N. Spon. 1906. Price 1s. net.—This convenient little table-book covers weights from 1 lb. to 1 ton, rising by single pounds, and from 1 ton to 100 tons by single tons; it has been compiled for the use of merchants and shipping agents, to meet the requirements of foreign Customs authorities. The arrangement is convenient, each page containing 28 lb. (1 quarter), and the weights being given both in lb. and in cwt., qr. and lb., up to 1 ton. The values for kilogrammes are stated to four decimal places, giving in the higher values no fewer than *nine*, and even *ten* significant figures! This seems rather absurd, for commercial requirements would be satisfied with less than half as many, and an all-round rule of four significant figures would have been more rational, scientific and convenient.

"Repetitorien der Elektrotechnik." Edited by A. Konigswerther. Vol. VIII.

"Elektrische Beleuchtung." By Berthold Monasch. Hanover: Dr. Max Jänecke. M. 5.60.

"Manual of Wireless Telegraphy." By A. Frederick Collins. New York: J. Wiley & Sons. London: Chapman & Hall. 6s. 6d. net.

"American Trade Index for 1906." English edition. Descriptive and classified membership Directory of the National Association of Manufacturers of the United States of America, arranged for the convenience of buyers. Eighth annual edition. New York City: The National Association of Manufacturers.

"Year Book of the Michigan College of Mines for 1905-1906." Houghton, Michigan: The College.

"The Physical Review," Vol. XXIII, No. 3, September, 1906. Lancaster, Pa., and London: MacMillan & Co.

"Continuous Current Dynamo Design." By H. M. Hobart. London: Whittaker & Co. 7s. 6d. net.

"Proceedings of the Incorporated Municipal Electrical Association, 1906." 5s. This volume contains copies of the presidential address and all the papers read at the convention held in London in June last, together with reports of the discussions thereon. A number of pages are devoted to reprints of the various Board of Trade regulations relating to electric lighting and tramway work. A full list of members and associates is printed, also a complete record of the titles and authors of all papers read before the association since its initiation.

Patent Turbine Pumps.—Messrs. Mather & Platt, Ltd., have very recently booked orders for a considerable number of their well-known turbine pumps, including two electrically-driven pumps for Rangoon, one for Messrs. Charles Jenners & Co., of Edinburgh, two for India, one for Honolulu, and two for South Wales Collieries, a large electrically-driven pumping plant for the Dearne Valley Colliery Co., Yorkshire, and four large electrically-driven pumps for the United National Collieries, Ltd., of South Wales. Besides the above, all of which are coupled to electric motors, they have also received an order from the South Staffordshire Main Drainage Commission for a patent turbine pump to deliver 2,000,000 gallons of water per 24 hours against a total head of 55 ft. This pump is to be driven by a gas engine supplied with gas from the South Staffordshire Mond Gas Co., at Tipton, and is the first pump of this type installed by the Commission.

A German Manufacturing Development.—A fresh development in manufacturing has been undertaken by the Bergmann Electricity Works Co., of Berlin, which is about to make a fresh issue of shares from £200,000 to £700,000. In explanation of this large increase, it is stated that the company's turnover has largely advanced in recent years. It amounted to £500,000 in 1904, and £650,000 in 1905, and the present year is expected to represent £800,000. The company has gradually embarked upon the production of a variety of new manufactures, including the construction of cranes, machinery and plant for mines and iron-works, and electricity meters, and more recently the output of steam turbines on the Rateau system has been commenced. The steam turbine department was started in July, and the business being done

is brisk. As, however, the enlarged works are still inadequate for the purpose, sites adjoining the buildings have been acquired for further extensions, and the additional capital is needed to provide for these various developments.

Dissolutions and Liquidations.—Standard Gas Engine Co., Ltd.—This company is winding up voluntarily, with Mr. H. Southwarth, 9, Chapel Street, Preston, as liquidator.

Kettle River Power Co., Ltd.—This company is winding up voluntarily, with Mr. A. G. Bartholomew, Salisbury House, E.C., as liquidator. Creditors must send particulars of their debts, &c., to him by November 15th.

Pollak-Virag Telegraph Syndicate, Ltd.—A meeting is to be held at 120, Bishopsgate Street Within, E.C., on November 7th, to hear an account of the winding up from the liquidator, Mr. W. S. Ogle.

Messrs. Hart & Jones (A. E. Hart & A. T. Jones, oil, colour and hardware merchants, sanitary and electrical engineers, Watford) have dissolved partnership. Debts will be attended to by Mr. A. E. Hart, who will continue the business.

Raymond-Phillips Electric Railway and Tramway Equipment Co., Ltd.—It has been resolved to wind up this company voluntarily, with Mr. Philip Mordant, of 10, Fenchurch Street, E.C., as liquidator.

Hyde Rubber Works, Ltd.—A meeting of the company is to be held at 3, Winckley Square, Preston, to hear an account of the winding up from the liquidator, Mr. James Todd.

Prism Globe Co., Ltd.—A meeting is to be held at 36, Spring Gardens, Manchester, on November 16th, to hear an account of the winding up from the liquidator.

Miller Signalling Syndicate (Foreign Patents), Ltd., and the British Miller Syndicate, Ltd.—Meetings are to be held on November 19th at 110, Cannon Street, E.C., to hear accounts of the winding up from the liquidator, Mr. E. Harper Stringer.

Trade Announcements.—The Union Cable Co., Ltd., have removed their registered office and warehouse to their new factory premises at 27, Eagle Wharf Road, N.; their telephone number is 975 North.

Messrs. E. P. Allam & Co., of Red Lion Street, E.C., wish the trade to take note that their registered telegraphic address is now "Smoothbore, London."

Messrs. Poole, Lauder & Co., have, from yesterday's date, removed their offices and warehouse to 46, Upper Thames Street, London, E.C., where all future communications should be addressed. Their only telephone number is 3,467 London Wall.

Catalogues and Lists.—The Joseph Dixon Crucible Co., 26, Victoria Street, London, S.W.—New publication entitled "Through 'Frisco's Furnace," showing how the maximum strength of steelwork of high buildings in San Francisco was preserved during the lamentable fire and disaster of six months ago by means of Dixon's silica-graphite paint, which enabled severe strains to be successfully resisted. The brochure (24 pp., 9¼ in. × 7½ in.) contains some interesting half-tone views of buildings as they appeared after the fire. Anyone interested can obtain a copy of the publication upon application.

Messrs. Mavor & Coulson, Ltd., Glasgow.—The October date-card gives a detailed record of one year's working of a "Pick-Quick" electric coal-cutter.

The Mirrlees Watson Co., Ltd., Glasgow.—8-page catalogue with art cover describing the "Mirrlees-Diesel" oil engine. Some neat half-tone illustrations appear of 35 and 80 B.H.P. slow-speed engines, and a four-cylinder 160-B.H.P. engine (completely enclosed type as supplied to the British Admiralty) to run at 430 revolutions.

We have received a six-page circular, giving illustrated information concerning A. W. Faber's improved calculating rules.

Messrs. Davis & Timmins, Ltd., King Cross, N.—Postcard indicating prices of finished hexagon nuts.

Messrs. Simplex Conduits, Ltd., Birmingham. — Leaflet describing their new form of iron-clad switchboard for lighting and power circuits. It is intended for colliery work and for other situations where circuits are exposed to damage by moisture or mechanical injury. The board is built up of a series of units, and the whole is mounted on a framework of Simplex screwed solid-drawn conduits. Each unit consists of a separate combined iron-clad switch and fuse, and any number can be arranged for, double or triple-pole, and for single or polyphase currents. The bus-bars are enclosed in an iron casing and are out of harm's way, the branch circuits between the bus-bars and switches being enclosed in conduit. The advantages claimed are:—The board is perfectly flame-tight; live parts are out of reach, being totally enclosed; a blown fuse cannot be replaced unless that particular circuit is dead; fuses can be replaced on any circuit without interfering with others; every circuit is separately controlled at the distributing centre; and no switch is necessary at the point where the power is utilised.

LIGHTING and POWER NOTES.

Aston.—The B. of T. has approved of the agreement with the Erdington U.D.C. for a supply of energy by the Aston T.C.

Annfield Plain.—A Yorkshire correspondent informs us that the U.D.C. has recently instructed Messrs. D. Balfour and Son and Mr. J. F. C. Snell to report on a scheme of electric lighting for the town, either in connection with a refuse destructor or by obtaining energy in bulk from the local power company, which is authorised to supply electricity in the district.

Brighouse.—The T.C. has adopted the following new scale of charges for energy, in lieu of the old charge of 6d. per unit for lighting: 5d. per unit on a minimum consumption of 80 units per annum. For power the price has been fixed at 4d. per unit up to 150 units per quarter, and 3d. on a minimum consumption of 160 units.

Brighton.—The Pavilion Committee of the T.C. has decided to purchase all the electric lamps required for the Pavilion from the Corporation Electricity Department, which, the borough surveyor reports, "can supply at lower prices than are now paid to local tradesmen."

At a recent meeting of the T.C. a letter was read from Councillors Sone and Tozer asking to be furnished with the facts respecting a breakdown at the Southwick power station, and inquiring, if such an accident had occurred, who would bear the loss. The Committee resolved:—"That Councillors Sone and Tozer be informed that the engineer reported to the Committee, on August 27th last, that on the 21st of that month the armature windings of No. 3 alternator at the Southwick works burnt out when the machine was being run up, and that, as the armature was still in the hands of the contractors, the cost of repairing the same would have to be defrayed by them, and that on September 23rd one of the turbines had some of its blades stripped, which are being replaced by the contractors at their own cost."

Canada.—Fort William (Ont.).—As soon as the Kakabeka Falls power plant is completed, electricity will be used for motive power in the extensive yards of the Canadian Pacific Railway, and electric locomotives will be utilised.

Welland (Ont.).—There are at present several electrical companies in the field at Welland all desirous of supplying electrical energy to several large industrial concerns which have recently commenced business.

Rossland (B.C.).—The use of electricity in the mines of British Columbia is everywhere increasing. The West Kootenay Power and Light Co., which supplies electricity to many of the mines in the neighbourhood of Rossland, has decided to add six Westinghouse step-up transformers of 1,875 kw., and 15 step-down transformers of 1,250 kw. to its existing equipment.

Continental Notes.—Italy.—The provincial authorities of Parma have granted a concession for a water power plant to be erected on the River Cento for the generation of electrical energy for lighting and power purposes.

Germany.—The municipal authorities of Bernburg are about to invite tenders for the establishment of an electricity works in the town, at an estimated cost of £45,000.

Belgium.—A large electric generating plant is approaching completion at the collieries of La Société des Houillères d'Anderlues, in the Charleroi district of Belgium.

Colchester.—By 11 votes to 10 the T.C. on October 3rd decided not to amalgamate the electricity supply and tramways departments.

Ferryhill.—The T.C. has accepted the offer of Messrs. Bolckow, Vaughan & Co., for public lighting by electricity, with 48 32-C.P. lamps at £201 5s., and 30s. per lamp per annum.

Gillingham (Kent).—The T.C. has decided to continue to supply energy in bulk to the Kent Electric Power Co. at 2¾d. per unit, on condition that the company undertakes to give a bulk supply to the T.C. at any time if necessary. For stand-by plant for the company the Council has decided to charge £3 per day, in addition to the cost of energy supplied.

Glasgow.—The T.C. purposes applying to Parliament for power to supply electrical energy to any property or works belonging to or occupied by it which are situated outside the boundaries of the city, and to charge for such supply any sum it may fix.

Grangemouth.—The new docks constructed by the Caledonian Railway Co., which were formally opened on Monday by Lady Wolfe Barry, are lit entirely by electricity.

London.—Islington.—The district auditor, in his report on the E.L. accounts for the year ending March 31st, 1906, refers to the energy supplied for public lighting as follows:—"The facts mentioned in my report on the previous year's accounts remained practically unaltered during the year 1905-6, the charge for the energy being 3·47d. per unit, apart from the provision or maintenance of the lamps. I observe that the Council have resolved not to exceed the aggregate charge made in the year 1904-5—viz., £15,734 5s. 5d., and that it is estimated that the increase of electric lighting of the streets will in the year 1907-8 have reduced the charge per unit to 2·24d."

The Lighting Committee brought before the B.C. last week a report and recommendation in brief, as follows:—"On March 2nd last the Council approved certain proposals for the extension of street arc lighting. An essential part of which scheme was that, notwithstanding it was proposed to erect and supply with electricity 245 additional arc lamps, the annual cost of lighting the streets by electricity should not be increased, but should remain a fixed charge of £15,734 5s. 5d., that being the amount which was paid for

such lighting in the financial year which ended March 31st, 1906. It was, however, fully understood that the result would be to reduce the charge per unit for electricity supplied for street lighting purposes from 3½d. to 2½d. per unit. On July 20th the Council resolved that all consumers of 50,000 units and upwards per annum should be charged at the rate of 3d. per unit. In making this recommendation it was the Committee's intention that this price should be applicable to private consumers only, but doubts having arisen as to whether this charge of 3d. per unit was intended to apply also to the public arc lighting, it asked the Council to pass a definite resolution on the subject. If the price for electricity supplied for street lighting is to be 3d. per unit, the effect will be to bring the total cost below the sum of £15,734 5s. 5d. upon the present consumption, and when the extensions are completed to increase it to £21,039." After a discussion, in which the working of the undertaking was criticised, the recommendation that the amount to be charged in respect of public lighting be a fixed sum of £15,734 5s. 5d. per annum until the Council otherwise directs, was carried by 29 votes to 15.

HACKNEY.—The E.L. Committee has recommended, upon the advice of the consulting and borough electrical engineers, that an additional generating set should be installed to meet next winter's demand. It is proposed to put down a 1,500-KW. set with condensing plant, piping, &c., at an estimated cost of £18,500. Rapid developments in the supply of energy for power purposes are taking place at Hackney. The Committee, in its report, says it has not overlooked the possibility of a bulk supply from the L.C.C. at some later date, and goes so far as to suggest that it would be problematical whether the L.C.C. would be able to supply the B.C. on more favourable terms than those upon which the latter could generate its own supply.

BATTERSEA.—In connection with the proposal of the L.C.C. to promote legislation next year authorising the Metropolitan B.Cs. to wire consumers' premises, the electrical engineer of Battersea has been instructed to report to the Council upon the estimated cost of wiring and fitting different classes of premises.

WESTMINSTER.—In the course of a discussion at the City Council meeting on October 4th, Mr. Tozer said that he had called the attention of Sir William Preece to a statement made recently in the Press that he (Sir William) had advocated high pressure gas instead of electricity for public lighting. Sir William Preece had replied as follows from Penrhos, Carnarvon:—"It is extraordinary how the report of my supposed opinion has been circulated. The gas people are very clever. What I said was that I considered that the incandescent gas mantle was superior to the ordinary glow lamp for illuminating a quay down here. The question of gas *v.* electricity was not under consideration. It was simply a question of illuminating an open space for a particular purpose, and no other lamp but a Welsbach mantle and a small glow lamp were under consideration, not even the question of supply, for the Town Council has both. . . . . If the question before them was electricity *v.* gas, of course I should plump for the former. I did not contradict the paragraph, for I learnt long ago that you cannot overtake a lie; it will have its course."

MARYLEBONE.—The Electricity Supply Committee, in a report issued on Tuesday, stated that a motor-generator is required for transforming the Council's standard pressure of supply of 240 volts to 100 volts, for the purpose of supplying certain consumers who had not changed over to the increased pressure, on account of the great cost attached to the carrying out of the alterations to the installations. Instead of purchasing a new motor-generator, which would entail an expenditure of from £500 to £600, the Committee has decided to make use of some of the old apparatus, which was taken over from the Metropolitan Electric Supply Co. The plant as it stood was only of scrap value, inasmuch as it was a specially designed for use with the Willesden supply. There is at the Rathbone Place sub-station a 100-volt battery which, in view of the increased pressure of supply throughout the district, is out of use at the present time. This 100-volt battery is to be removed to Manchester Square sub-station, to work in connection with the motor-generator already referred to. In order to maintain the 100-volt supply at the generating station, it is necessary to use one of the main trunk feeder cables, and by adopting the foregoing scheme, the cable can be used for supplying the high-voltage consumers. The Committee further reported having received a communication from the Metropolitan Electric Supply Co., questioning the right of the Council to lay mains and supply electricity for certain street lamps to be erected on the south side of Oxford Street. Counsel's opinion has been obtained on the point, and the Council was advised that it is fully within its rights in laying mains and supplying electricity for the lamps in question.

STEPNEY.—Application is to be made to the L.C.C. for a loan of £13,713 for electricity purposes. Wapping High Street and Wapping Wall are to be lighted with arc lamps. Additional feeder mains are to be laid through 13 streets owing to the large increase in load. Mains are also to be laid through four other streets. The following charges have been decided upon for charging accumulators of motor-cars: 5s. per car per charge, and 1s. per ignition battery or other small portable battery per charge; further 8d. per unit for energy consumed between sunset and 10 p.m., and 1d. per unit at all other times. For cars and batteries charged regularly the fixed charge per car is not to exceed 10s. in any one month, and the fixed charge per ignition or other portable battery shall not exceed 2s. in any one month.

POPLAR.—The system of manufacturing disinfectants by electrolysis of salt water is reported by the Public Health Committee to be successfully established on a permanent basis. The Committee has offered to supply the Guardians, the Sick Asylum, and the local L.C.C.'s schools with the disinfectant free of charge.

L.C.C.—The Finance Committee at Tuesday's meeting submitted a report with reference to expenditure incurred by the Shoreditch B.C. in changing over the pressure of supply from 150 to 240 volts. It appeared that the B.C. had applied for a loan of £5,000 (half of the estimated cost) for the purpose for a period of five years, and as the Treasury had no objection to the proposal, the L.C.C. decided, on the recommendation of the Committee, to sanction the borrowing of the money for the term in question.

Menai Bridge.—The U.D.C. has decided to support the E.L. scheme submitted by the Mona Electric Light Co. The company undertakes to supply energy to private consumers at 6d. per unit; for public lighting at 3d., and for power at 2d. per unit.

Paisley.—The T.C. purposes supplying electrical energy to Johnston for industrial purposes.

Newport.—The Corporation has decided to make application to the L.G.B. for powers to borrow £20,000 for electric supply purposes to cover the next three years.

Redcar.—The U.D.C. has asked the Cleveland and Durham Electric Power Co. to submit a scheme for public lighting by electricity.

Rochdale.—A scheme has been proposed for mains extensions estimated to cost £3,000, and has been submitted to the works sub-committee for report.

Stockton-on-Tees.—The T.C. has referred to a committee a request from the Cleveland and Durham County Electric Power Co. for the Corporation to consider the general question of electric power supply by the company within the borough.

Sutton Coldfield.—It has been intimated to the T.C. that the E.L. Committee will shortly ask the Council to grant powers for free wiring, because the Birmingham Corporation is laying in the whole of the gas services for every possible consumer free.

Swindon.—The T.C. has decided to convert 111 gas lamps into electric (tantalum) lamps at a cost of £253.

Swinton and Pendlebury.—The L.G.B. has sanctioned a loan of £12,300, being applied for by the U.D.C., for the E.L. undertaking.

Tiverton.—Messrs. Foote & Milne, Ltd., of London, recently made certain proposals to the T.C. for providing a plant suitable for the public electric supply. The company stated that they would take a lease of a suitable site for a generating station, as selected by the Corporation, for 30 years at a nominal rental, and would erect on the site a building completely equipped, and lay mains in the streets and roads specified to the value of from £6,000 to £7,000. The plant would have a capacity of about 3,000 16-C.P. lamps. It was proposed to run three-wire distributing mains in the streets. The letter went on to say that on completion of the works, the Corporation would have the same from them for 30 years at the yearly rental of £440. They should be appointed electrical engineers to the Corporation for a period of two years, and their remuneration should be half of the net profits derived by the Corporation in each of such years. The opinion was expressed that Messrs. Foote & Milne could not carry out the scheme without the sanction of the L.G.B. and the B. of T., and the Council decided to reject the offer.

West Bromwich.—We regret that a note last week, referring to the issue of a report on additional wiring regulations for more effectually ensuring the reliability and safety of electric wiring and fittings on consumers' premises, was accredited by mistake to the E.L. Committee of West Bromwich; it should have been Wednesbury.

The T.C. has received from the L.G.B. sanction to a loan of £5,150 for electricity purposes, and a further loan of £448 for excess expenditure has been applied for.

West Ham.—The motor-generators supplied by the General Electric Co. having been erected at the power station, a two-phase supply in Canning Town was commenced on September 26th. It is hoped to extend the supply to Stratford in a few days. The excavation and conduit works in connection with the supply to Silvertown have been completed. Serious damage having been done to a transformer chamber, owing to a leakage of water from pipes belonging to the Metropolitan Water Board, the matter has been referred to the town clerk to advise as to the liability of the Board.

Wigan-Standish.—Standish U.D.C. has decided that it is not expedient and not in the best interests of the ratepayers to incur at the present time the large capital expenditure, about £3,700, and the annual maintenance (£646) necessary to establish electricity works. The Wigan T.C., which had been approached on the subject, decided on October 3rd to offer to supply energy in bulk to Standish at ¾d. per unit, with the following annual charges per KW.:—Maximum demand 100 KW., 64s.; 150, 62s.; 200, 60s.; 250, 58s.; 300, 56s. 6d.; 350, 54s.; 400, 52s. 6d.; 450, 50s.; 500, 48s. 6d.

ELECTRICITY IN STEEL WORKS.

Of all the recent applications of electricity, few offer a wider sphere of usefulness than its employment in modern iron and steel works, where even the raw materials can now be successfully dealt with in the electric furnace. The object of the present article is, however, more in order to demonstrate the adaptability of the electric motor for the varied motive-power requirements of such works, among which none has called for more ingenuity than the driving of live rolls.

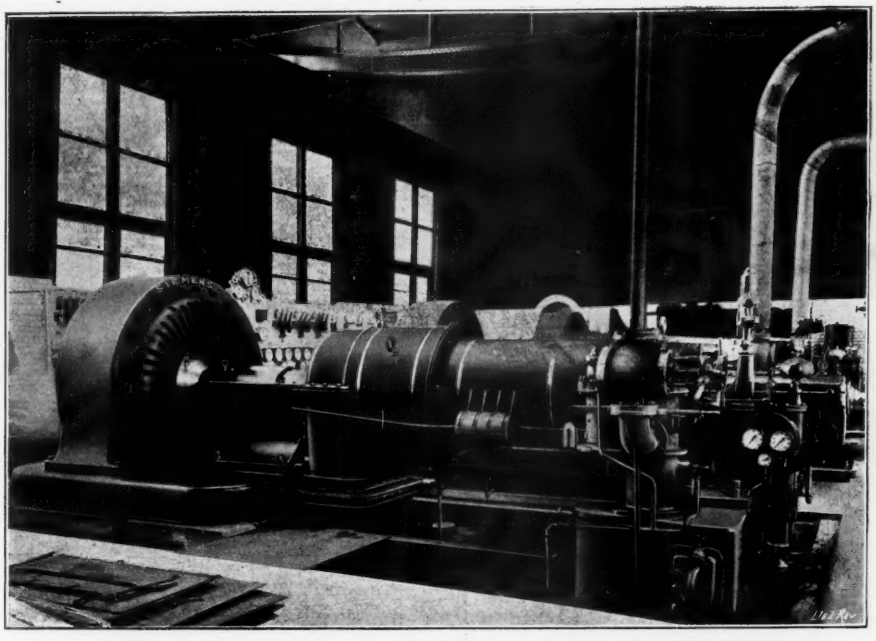


Fig. 1.—Turbo-generating Plant at the English McKenna Process Co.'s Works, Birkenhead.

Although this class of work has not received much attention in this country up to the present, yet Messrs. Siemens Bros., to whom we are indebted for the following information, have several important contracts of the kind in hand, and have on the Continent, carried out a great number of installations of a similar character.

First and foremost in order through such a works, comes the generating plant, for which purpose we have taken the installation supplied by the above firm for the English McKenna Process Co., Ltd., of Birkenhead.

This plant consists of three turbo-driven three-phase 25-cycle generators, each of 750 kw. capacity, for supplying energy at 440 volts pressure, to 500-h.p. motors for driving a series of rolling mills, and to other motor-driven plant. These generators are driven by Willans - Parsons turbines, with a speed of 1,500 r.p.m.

Steam for the above plant is supplied from two Babcock & Wilcox boilers and from several Hyde boilers fired by waste heat from the rail furnaces.

Fig. 1 shows one of the turbo-generators, and fig. 2 the main switchboard which controls the supply to the various power and lighting circuits throughout the works. The board contains 15 panels in white marble, six of which control two feeders each, and the remainder the three generators, exciting plant, rotaries, &c.

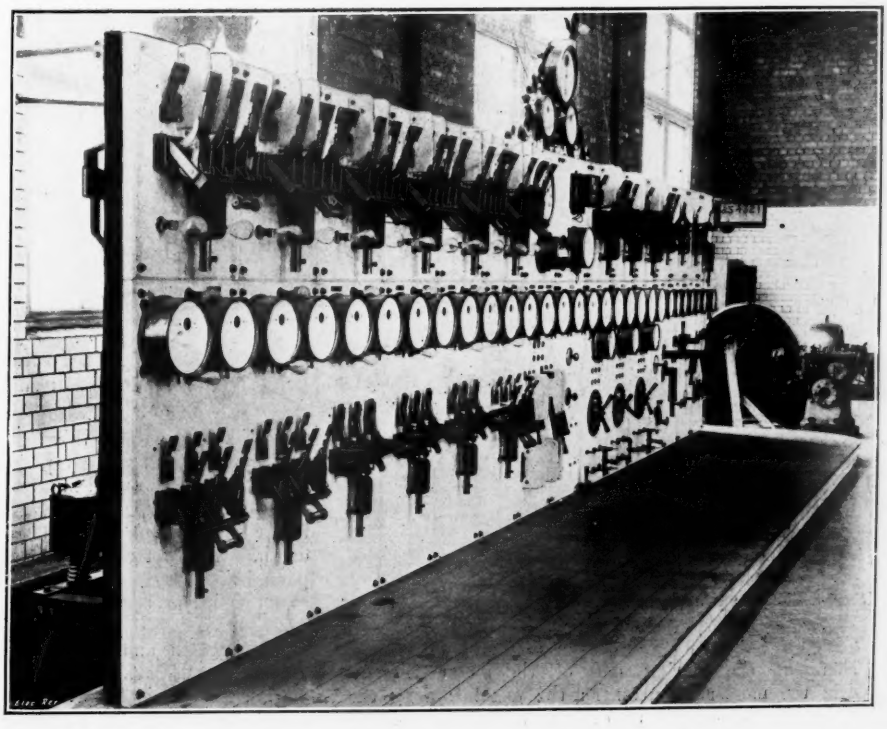


Fig. 2.—Switchboard at the McKenna Co.'s Works, Controlling Turbo-generators, six 500-h.p. Main Roll Motors, and Auxiliary Plant.

Of course, where blast furnace gas is available, the argument for the use of gas engines is strong, since there is little doubt that power can be generated more cheaply by

large gas-driven units than by means of gas-fired boilers and steam-driven generators.

One of the most important applications of electric power is undoubtedly to the driving of live rolls, and there is probably no class of service in which electric motors are subject to more severe strains.

For reducing the severity of the shocks, fast and loose belts have sometimes been employed; another method is to use a set of reversing gears and friction clutches which allow the motor to run continuously in one direction. With both

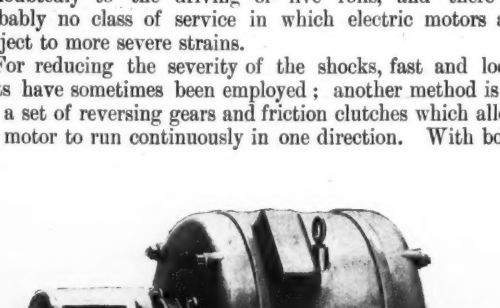


Fig. 3.—Heavy 3-phase Motor for Driving Live Rolls.

of these plans, however, the parts are liable to rapid wear and the cost of upkeep is high.

By far the most usual practice at present is to gear the motors direct to the rolls, making the motor so substantial in construction, and designing it with such high overload capacities from the commutation standpoint, that it will withstand successfully a reversal of current at full speed, the torque exerted by the reverse current being used for bringing the rolls to rest. This method is much the simplest and most convenient mechanically, as it affords a means of starting and reversing the rolls in a minimum of time, and with a properly-designed motor and controller the results obtained by it are excellent.

For meeting such heavy duties standard motors are not suitable, and Messrs. Siemens have designed special motors, both of the continuous and three-phase types, for the purpose. Figs. 3 and 4 show two views of three-phase motors for this service. It will be noticed that

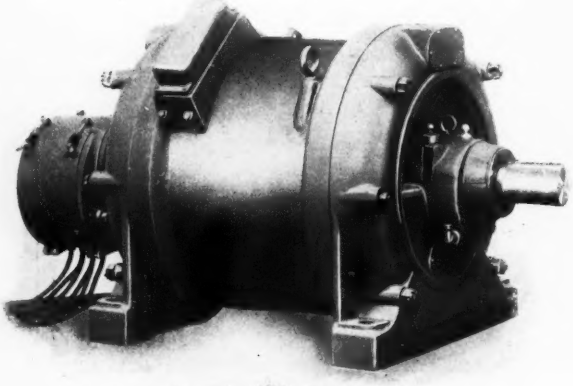


Fig. 4.—View showing End Shield of above Motor.

the shaft at the bearing end of the motor is supported in the most rigid manner: the metal forming the bearing casing is carried as directly as possible to the supporting feet, thus avoiding overhang and the possibility of chattering due to the heavy intermittent strains which come upon the motor pinion.

The electrical characteristics of the motors are also such as to enable them to withstand the heavy current rush which occurs at starting and reversal.

The controllers for these motors have to withstand almost equally severe service; fig. 5 shows a special type of controller for this class of work, consisting essentially of a marble panel, upon which are mounted heavy contact blocks.

The current is controlled by contact fingers with massive carbon tips, the motion of the fingers being obtained by means of a cam shaft with a handwheel.

The controllers also have magnetic blow-outs, and the resistances may be arranged self-contained with the controller, as shown.

For driving main non-reversing rolls, both three-phase and continuous-current motors of massive design are employed; the drives may be either direct, or through a rope drive, and in the latter case two or three sets of rolls may be driven from one motor.

Fig. 7 shows a motor-driven starter for one of these mill motors. The contact blocks are mounted upon a marble panel, and the sliding contact shoe is operated by a traversing screw worked by a pilot motor which may be controlled from a distant point. For large motors of the

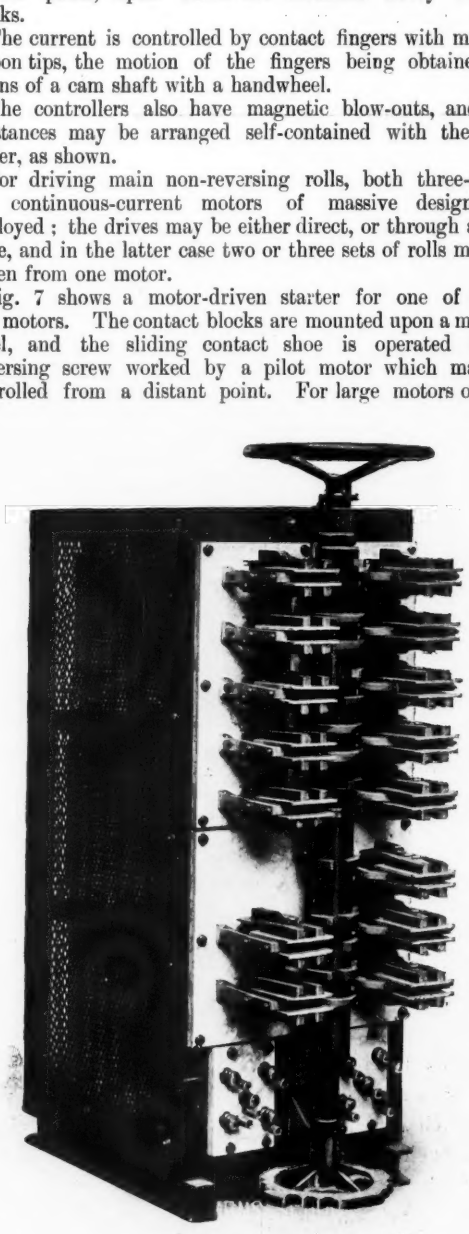


Fig. 5.—Controller, with Self-contained Resistance, for Live Roll Motor.

three-phase type, the firm has also designed a special starter, known as the hot-water type, which consists of a series of contact plates suspended in a tank. By means of a small motor-driven circulating pump, water is made to rise or fall in the tank and submerge the contact plates to any required depth. The water when it comes into contact with the plate, boils at the surface and gives off a small quantity of steam which escapes through an outlet pipe. By thus taking advantage of the great latent heat of steam, a starter of moderate size and cost can be produced capable of carrying very heavy currents. These starters have been used with the greatest success for main roll motors of large size. An illustration of such a starter is shown in fig. 8.

The motors used for most purposes about steel works have a very intermittent load, with periods in which the motor is either standing or running light and drawing only a small amount of current. For the smaller motors about the works this variation in power required does not react unfavourably upon the generating station, since there are usually a large number of motors, and their variations tend to neutralise

each other and produce an aggregate demand of fairly uniform character. In the case of large motors such as those for driving main rolls, however, the load variation assumes more serious proportions, and it is sometimes desirable to neutralise the excessive peak loads which would otherwise affect the generating plant. The provision of a fly-wheel on the rolls or motor shaft, of suitable weight, is the most obvious method of accomplishing this, but care must be taken to design the motor and its control gear so as to permit a drop in speed without a corresponding rise in current demand, and thus enable the stored energy of the fly-wheel to be utilised.

This can be accomplished in the case of a D.C. motor by means of a compound field winding, and with an induction motor by inserting a suitable resistance in the motor circuit, so as to increase the slip of the motor during the period of heavy load.

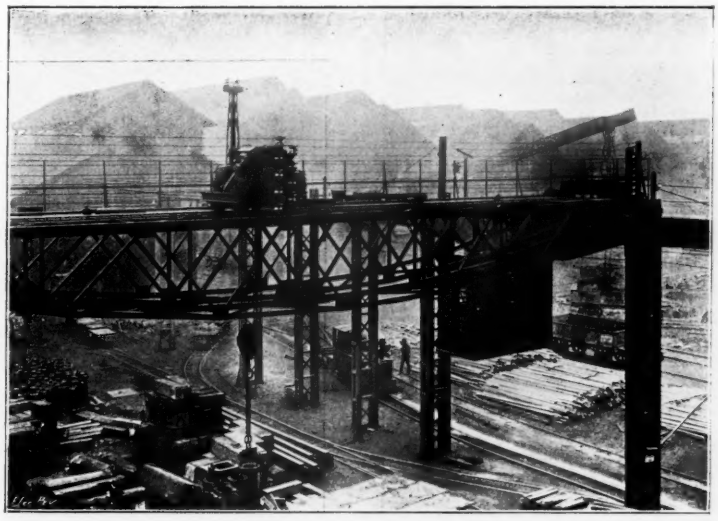


Fig. 6.—Electric Travelling Crane for Handling Moulds.

In order to secure the best results under this plan, it is necessary to construct first, with as much accuracy as possible, a load diagram representing the heaviest duty of the mill, and showing the times required for the passes and intervals and the power at each instant. An integration of the area of this load diagram will then give the average power to be supplied by the motor. The motor should be chosen to meet this power, but with ample overload capacity and the fly-wheel proportioned so that by a permissible reduction in speed it will provide an amount of power at each pass, equivalent to the corresponding load peak above the average. There are cases, however, in which the peak loads are either so high or of such long duration that, in order to completely neutralise them by means of a fly-wheel direct coupled to the motor or rolls, the weight of the fly-wheel required would be impracticable. In such cases the excess demand on the generating station may be supplied by a storage battery; but the first cost of a storage battery is high, and also its cost of upkeep, and this has led engineers to search for some simpler means of accomplishing the same result. This was achieved by providing a fly-wheel motor-generator set for equalising the power taken by the roll motors. The three-phase motor of the motor-generator set draws from the generating station an approximately uniform current, which is equal to the average of the currents required by the main roll motors. The variations in power are neutralised by the fly-wheel in a manner similar to that already described in the case of the fly-wheel direct-coupled to the rolls; but by coupling it to the motor-generator it is possible to run the fly-wheel at a much higher speed, and, therefore, with the same weight of wheel, to store a far greater amount of energy. A better but slightly more costly arrangement is to have a separate generator on the motor-generator set for each main roll motor. When this is done a simple means is also afforded of varying the speed of either

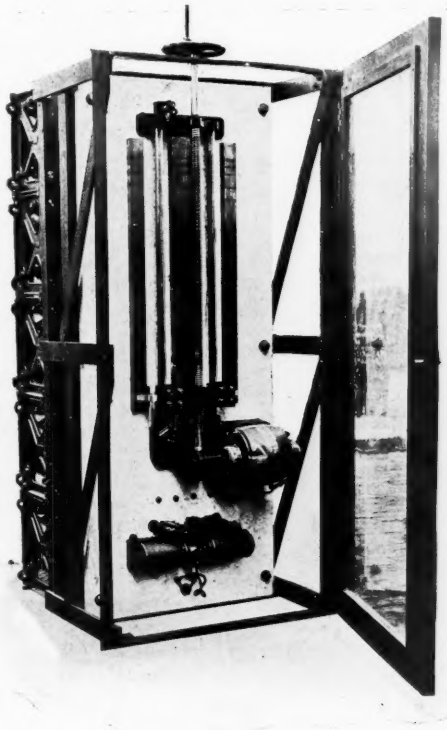


Fig. 7.—Motor-driven Starter for Main Roll Motor.

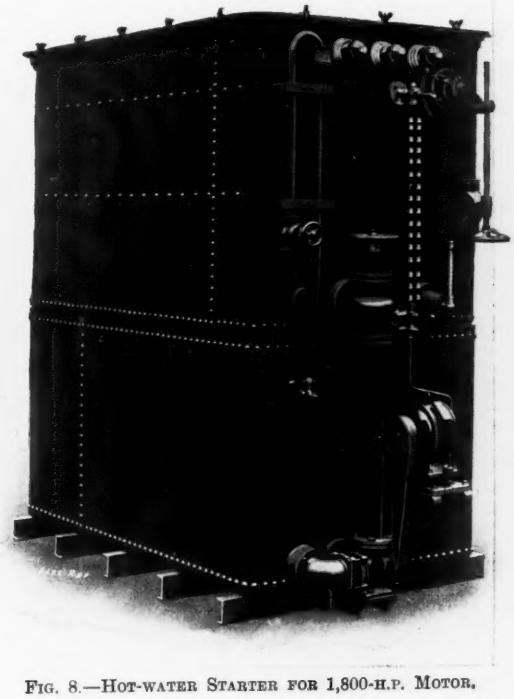


Fig. 8.—Hot-water Starter for 1,800-h.p. Motor.

main roll motor, by changing the field strength of its corresponding generator.

To be successful, the form of drive adopted must be one which will obviate the necessity of handling directly the enormous currents required for this work, and at the same time be capable of damping out the enormous fluctuations in the load during the rolling process.

Such a method is supplied by the Siemens-Ilgner system, in which the motor-generator, of special design, is interposed between the power station and the mill motor.

The operators' bridge shown in fig. 11, and situated over the main rolls, contains the controlling equipment for the mill motor.

The speed and direction of the latter are simply controlled by means of a rheostat lever, which varies the field of the generator portion of the motor-generator; the system involving the handling only of a small exciting current.

Fig. 14 is a diagram of the Siemens-Ilgner system, as applied to reversing main rolls. The arrangement has the great advantage that its efficiency remains practically constant at all speeds, and that the power required for accelerating the masses at the beginning of each pass is regained and stored in the fly-wheel when the masses are brought to rest for the reverse pass.

On a yearly production of 300,000 tons of billets, each weighing approximately 2 tons and of varying length and hardness, it has been estimated that the difference in cost, representing the saving due to electric driving, would be between £6,600 and £14,000, figures which in themselves warrant the closest consideration.

Our remaining views illustrate sundry other power appli-

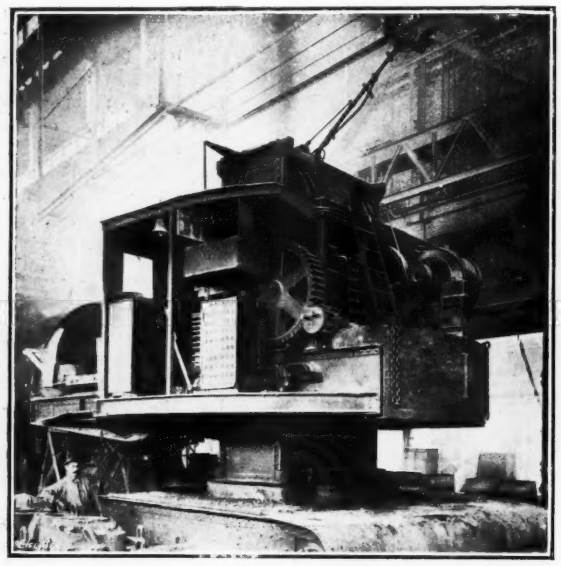


Fig. 9.—Heavy Electrical Ladle Crane.

Fig. 10.—A Motor-Driven Charging Machine.

Fig. 11.—View Showing Control Platform with Gear over Main Rolls.

cations, of which fig. 6 shows an electrically driven travelling crane for handling moulds; fig. 9 a heavy ladle crane equipped with individual lifting, slewing, tipping and travelling motors; and fig. 10, a motor-driven charging machine; while fig. 12 is a diagram of the power required for rolling out a 4-ton billet. During the initial

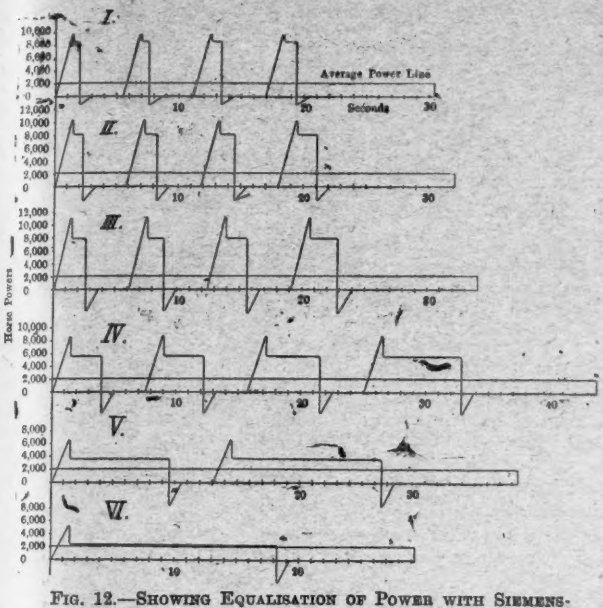


FIG. 12.—SHOWING EQUALISATION OF POWER WITH SIEMENS-ILGNER SYSTEM OF DRIVING REVERSING ROLLS.

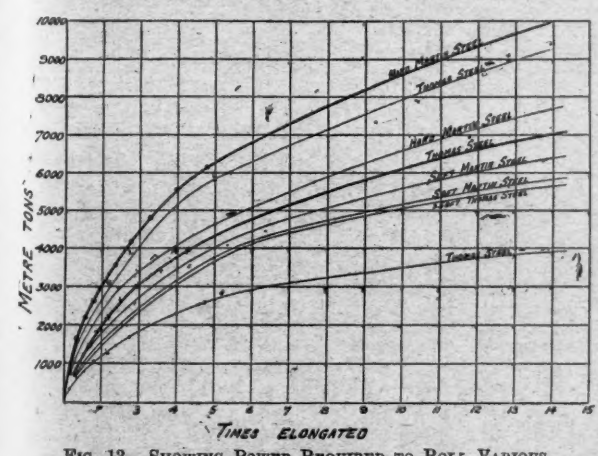


FIG. 13.—SHOWING POWER REQUIRED TO ROLL VARIOUS CLASSES OF INGOT.

stages, when the billet is short, the loads are heavy and of short duration; the powers gradually decrease, and the length of time during which they are applied increases.

The other diagram, fig. 13, shows the work necessary at the roll shaft for elongating to different amounts 2·2-ton ingots of various kinds of steel.

We are indebted to Messrs. Siemens Bros. for the information and illustrations in the foregoing article.

TRAMWAY and RAILWAY NOTES.

Audenshaw.—The U.D.C. on October 4th decided to take steps to obtain an amended order, to enable the tramways to be transferred to Manchester T.C.

Australia.—NEW SOUTH WALES.—The New South Wales Government announces, says the *Times*, that it is prepared to receive applications for three important posts in the railway and tramway service of the State. The principal post is that of Chief Commissioner, which carries with it a salary of £3,000 a year. The other appointments are those of Assistant Railway Commissioner and Commissioner of Tramways, the remuneration in each case being £1,500 per annum. The Chief Commissioner will have supreme authority in the management and maintenance of the State railways and tramways. These appointments will be for a term of seven years, renewable for like periods, and are made under the New South Wales Railways Acts. Full particulars can be had from the Agent-General for New South Wales, 125, Cannon Street, E.C., to whom applications must be sent on or before November 19th, 1906.

Ayr.—A long discussion took place at the T.C. on a recommendation by the Tramways Committee to apply for a provisional order to extend the tramways on the Whitletts Road to the limits of the municipal boundary, and also to extend them by way of Craigie Road, Victoria Bridge and Holmston Road to join the existing tramways at Burns's Statue Square, and that in the order power be asked to run motor-buses over the proposed route with a view to testing the traffic before the tramway rails were laid. Reports on alternative schemes were submitted, the chief difference being the amount of double track. The one scheme, with 2·75 miles of single track, was estimated to cost £16,904, and £6,350 for electrical equipment; and the other £14,910, with £6,350 for electrical equipment. The total estimated cost of construction and working was 6·25d. per car-mile on the first scheme, and 5·9d. on the second. The Council decided to delay the scheme in the meantime, the opinion being expressed that the proposed branch line would not be financially successful.

Cleckheaton.—The U.D.C. has declined to entertain an offer made by the Yorkshire (Woollen District) Traction Co. to apply for powers under the Light Railways Act for the extension of the electric tramways to Scholes in consequence of the conditions imposed, viz., that the tenure shall be for 42 years, at the expiration of which the Council shall have the right of purchase at a fair market value as a going concern, and until the date of purchase the company shall have running powers over the light railways in the district on such terms as shall from time to time be agreed to, or failing agreement, fixed by arbitration, and that the Council will not oppose the application for cessor of powers in regard to the unconstructed lines authorised by the Spen Valley Light Railway Order, 1901.

Continental Notes.—MONT BLANC RAILWAY.—Herr Feldmann, the engineer partly responsible for the monorail suspension railway of Barmen-Elberfeld-Vohwinkel, and a line on a similar principle which is now being constructed up the Wetterhorn, has worked out a scheme for a railway to ascend Mont Blanc, of which the following details are available. The work will be divided into three sections, the two lower sections being of the ordinary funicular type, and the upper section being on the suspension model, by means of which all tunnelling will be avoided. It is proposed to start from Chamonix, 1,020 metres above the sea, to the Boissons glacier, which reaches 2,450 metres altitude. This distance will be covered in two sections. From Chamonix to Para there is a horizontal distance of 2,120 metres with a rise of 600 metres, and thence to the top of Boissons glacier, a distance of 1,485 metres with a rise of 814 metres. Here the third section will commence, which will bring the line in three stages to the top of the Aiguille du Midi. These three stations will be connected by short galleries or tunnels. The method of construction is shortly as follows:—The carriages, which are interconnected and held together by traction cables, will run on two suspended steel cables. The suspended carriages will each hold 20 passengers. The traction

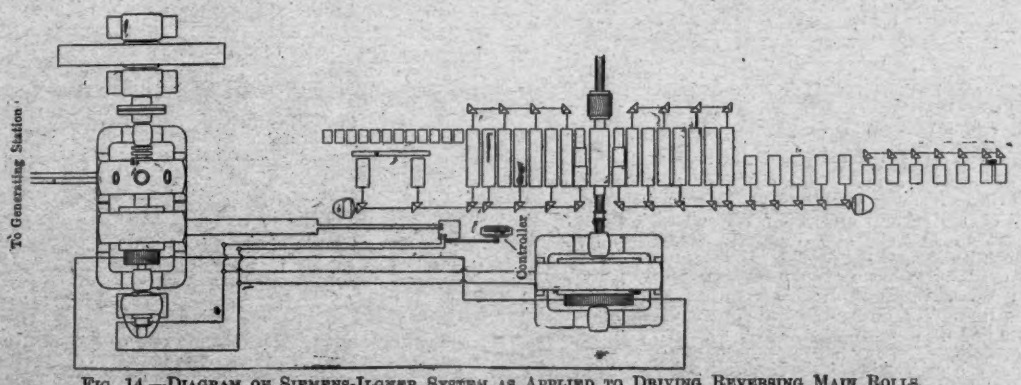


FIG. 14.—DIAGRAM OF SIEMENS-ILGNER SYSTEM AS APPLIED TO DRIVING REVERSING MAIN ROLLS.

cables are worked by electric motors. The suspension cables are to have a diameter of 44 mm. They are placed one over the other by means of pulleys built on masonry on the mountain side, and are provided with counter-weights. They are to be capable of resisting a permanent strain of 30 tons, and are tested to 300 tons, so that one cable will be quite sufficient to bear the weight of the train, if the other should break. It is expected that the works will take from three to four years to execute. One year each is required for the two lower sections, and one or two years for the completion of the upper parts. The construction of the funicular sections is estimated to cost £70,000 all together, and that of the suspension type about the same amount. A sum of £20,000 will, it is estimated, cover general expenses and interest, bringing the total capital required to £1,600,000. It is proposed to charge 30 fr. to 40 fr. per trip, and with 15,000 passengers per year there would be a revenue of £24,000. The expenses of working are put down as only £5,000, which leaves a net profit of 12 per cent.

Asia Minor.—The British Consul at Damascus, in a recent report, states that that town acquired a new interest in 1905 when it became the scene of the first electrical enterprise in Turkey. A concession was obtained by a Turkish functionary and made over to the Société Imperiale Ottomane des Tramways d'Eclairage et de Force Electriques de Damas, a Belgian company, with a capital of £240,000. The terms of the concession comprise a monopoly of electric traction, light, and power, and a right to establish a telephone service. The company is under contract with the municipality to light certain streets of the town. A force of 1,200 H.P. is derived from the falls of the River Barada at Et Tekiye, 22 miles from Damascus. The original plan was for five miles of tramways, crossing the city in two directions. For the present only 3½ miles, connecting the suburbs of Meidan and Salhiyeh, are being built. The company has encountered much legal, transport and engineering difficulties. The report states that the bulk of the work at the falls is finished, and in the town rails are laid on half of the 3½ miles; and the transforming stations, depôts, &c., are nearly complete.

Spain.—Work has just been commenced on the construction of an electric railway from Villefranche to Puigcerda (Gerona). In connection with the line, a large power station is to be erected at Mont Louis.

Croydon.—The last remaining length of the Croydon and Mitcham tramway is now in operation.

Darlington.—On the 4th inst., at a meeting of the T.C., a report from the Tramways Committee was submitted favouring the abolition of ½d. fares. The electrical engineer, Mr. Lunn, estimated that there was a loss of from £3 to £5 per week by the ½d. fares, and suggested a scheme of 1d. fares. This report favouring 1d. fares was adopted.

Folkestone.—The T.C. has decided to send a deputation to inspect the Dolter tramway system at Rotherham. The Council is pledged to use the surface contact system for the proposed tramways in the town.

Gateshead-on-Tyne.—The B. of T. has granted a further extension for 12 months, of the period for completing the light railways of the Gateshead and District Tramways Co. to the borough boundary at Wrekenton. A member of the T.C. having expressed the hope that the company would not delay beyond the 12 months, it was pointed out that the delay was due to the action of the B. of T. in refusing to allow the tramway to cross some sidings.

Glasgow.—The T.C. has decided to apply to Parliament for power to construct additional tramway lines to the extent of about 1 mile 5 furlongs.

Gomersal.—The B. of T. has informed the U.D.C. that it has granted the B.E.T. Co. a further extension of time for a year for the completion of the undertaking under the Spen Valley and Morley Light Railways Order.

Leytonstone.—The new system of electric tramways being laid down by the U.D.C. is now almost completed, and it is expected that electric cars will supersede the present horse trams about the middle of November.

London.—Islington.—The L.C.C. has notified the B.C. of its intention, as soon as the electrification of the tramway route in Upper Street is completed, to apply to the B. of T. for approval of the conduit system for the following routes:—(1) Highbury Station *viâ* Holloway Road to Archway Tavern; (2) Old Street *viâ* City Road to the Angel public house; and for approval of the overhead trolley system for the tramway route along Camden Road, Parkhurst Road and Seven Sisters Road, to Finsbury Park. The Borough Council has unanimously agreed to adhere to its former decision, viz., that the system adopted should be the conduit.

L.C.C.—The undertaking of the London Southern Tramways Co. was transferred to the Council on October 1st. It is proposed to seek authority in the session of 1907 to convert the lines to electric traction.

Lancaster.—Councillor James Heald, the Chairman of the Electricity Committee of the Corporation, in view of the November elections, recently addressed his constituents in regard to the tramways question; he denied that he was opposed to municipalisation, but explained that he was not such a slave to sentiment as to perpetuate a loss of £3,000 a year on the electric tramway system. The loss to the borough up to date was £11,258, and nothing had been allowed for depreciation. There had been a good chance to lease the trams to a syndicate, but the offer was rejected. The recent change in fares and the abolition of ½d. stages had resulted in 18,000 fewer passengers being carried in the busy holiday months of August and September, when there should have been a record owing to the Royal Lancaster Show and an extended Morecambe season.

Llandudno—Colwyn Bay.—Representatives of Messrs. Bruce Peebles & Co., the contractors for the construction of the Llandudno and Colwyn Bay Electric Railway, have recently interviewed Mr. A. Morton, the electrical engineer, and Mr. E. P. Stephenson, engineer and surveyor to the Llandudno Council, respecting matters of construction, &c. It is thought probable that the line between Llandudno West Shore and Rhos-on-Sea will be in operation by next Easter.

Newcastle-on-Tyne.—At a meeting of the Corporation Tramways Committee on the 2nd inst. a lengthy report was submitted from the tramways manager, giving a list of several suggested extensions and the cost of carrying them out. In every instance Parliamentary powers would have to be secured. The Committee approved of the carrying out of two of these proposals, and agreed to recommend to the Council that they should be included in any Parliamentary Bill that it might promote next session. In such an event powers are to be sought for the construction of an extension from Heaton Road to Benton Road, at a capital cost of, approximately, £10,600, exclusive of street improvements; also for the construction of a line from the North Road to join the Tyneside tramways at South Gosforth, at an approximate cost of £20,000 exclusive of street improvements. All the other proposed extensions were abandoned for the time being, it being considered inadvisable at the present time to proceed with them. With regard to the extension from Stanhope Street to the Fenham estate, it was agreed to recommend the Council to proceed with the work at once. This proposed extension had already been sanctioned by the Council, and powers for carrying out the work have been obtained. The manager of the tramways stated that he had all the necessary materials to start the work at once.

Newport.—The Corporation has rejected a proposal to run the trams on Sundays. When the Corporation electric tramways were inaugurated, a few years ago, a poll of the ratepayers was taken, with the result that a majority were against Sunday running.

West Ham.—Application is to be made to the B. of T. for a prov. order authorising the construction of the following tramway extensions: (1) Plaistow Broadway and Greengate Street; (2) Barking Road (from Canning Town terminus to the centre of the Iron Bridge); (3) Prince Regent's Lane. The Board has given consent to the construction of the track for the extension of the tramways to Leyton.

TELEGRAPH and TELEPHONE NOTES.

Alaska.—The *Electrical World* states that General Allen, Commander of the American Signal Corps, has been instructed to install the duplex system on the Alaskan cables. The traffic has grown so large that the operators cannot cope with it, even by working day and night. During April the receipts amounted to £3,700, and if all official telegrams had been charged for, the receipts would have equalled about £200 a day. To improve the service, the landlines north of Valdes to Eagle City are to be reconstructed.

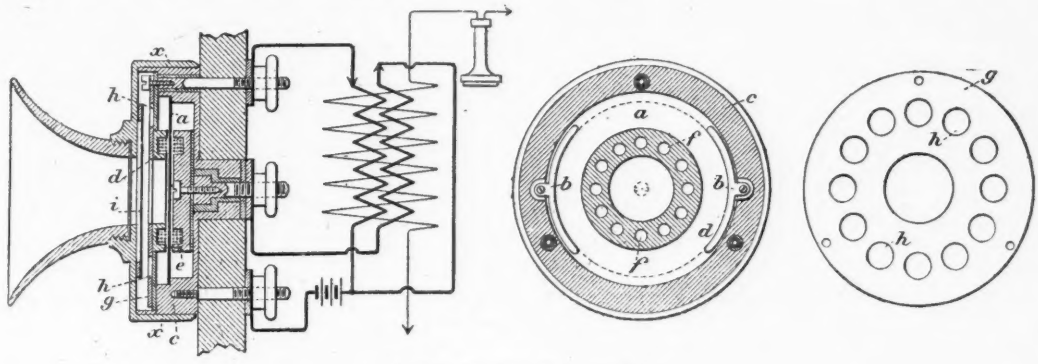
Canada.—As indicating the growth of the telephone service in Canada, since the Act of last Session placing telephones under the jurisdiction of the Government Railway Commission, there have been no fewer than 300 applications filed with the Dominion authorities at Ottawa for new lines, extensions, crossings, and the like.

Manchuria.—The Chinese Government has protested to the International Bureau at Berne against the continued control of the Manchurian telegraphs by Japan, having failed to obtain any concession by direct negotiation with the latter. Japan also controls the cable between Dalny and Japan.

The New Far-Eastern Cable.—It was recently mentioned in this column that the Eastern Extension Telegraph Co. had obtained a concession from the Dutch Government to land a cable at Java for a period of years ending in 1944, the cable being laid to the Cocos or Keeling Islands, belonging to the Government of Ceylon. It was then suggested, on the authority of a Berlin newspaper, that the new cable would be a serious competitor to the cable enterprise of the German-Netherlands Telegraph Co., of Cologne. The latter company now states that it is incorrect to assume that the new cable will be a rival to its cable in the Pacific Ocean between Menado-Yap-Guam and between Yap and Shanghai. On the contrary, the Java-Cocos Islands line is expected to be a new feeder to its service—as, for instance, for telegrams from Africa—and, consequently, will presumably lead to an increase in traffic. It is further mentioned by the company that the cable between Java and the Cocos Islands does not represent the establishment of a first connection between the Dutch Indies and Australia, but that it only adds a fourth to the three lines to Australia which have been in existence for a long time past. As a

consequence, the conclusion is fallacious as to a possible diversion of the present traffic between the Dutch Indies and America, *viâ* Australia and the British Pacific cable, especially as the rates for the route *viâ* Australia are higher than those obtaining *viâ* Menado-Yap-Guam.

New Microphone.—A new type of microphone has been brought out by the Société des Téléphones de Zürich, for which a greatly increased efficiency is claimed. The carbon contacts are usually placed behind the diaphragm, but in this case they are on both sides; so that while the resistance of one set is diminished by flexure of the diaphragm, that of the other set is increased, and *vice versâ*. In the figures, the diaphragm *a* is fixed to the metallic box *c* by springs *b* in such a way as to be free to vibrate. In front of the diaphragm is an annular metal plate *g* attached to the outer edge of the box, and perforated with holes *h* to prevent it from vibrating. This plate carries an annular disk of carbon *d*, fixed upon the side facing the diaphragm, and provided with cavities *f* filled with carbon grains. Behind the diaphragm a carbon disk *e* is placed, similarly provided with cavities filled with carbon grains. When the apparatus is in a vertical position, the carbon grains on both sides of the diaphragm make contact with it and with the carbon disks. The battery current is led into the diaphragm, and divides to the two disks. The induction coil has two primary windings, in circuit respectively with the two disks,



A New Double Microphone.

and wound both in the same sense, but connected in opposition, as shown. Vibrations of the diaphragm increase the resistance of one circuit and decrease that of the other, and the resultant variations of current obviously produce a combined resultant effect of increased magnitude upon the induction produced; it is stated that the ratio of the current change, compared with that obtained with an ordinary microphone, is as 3 to 1. Moreover, it is claimed that while the percentage current variations with the latter are unsymmetrical about the mean value, in the case of the new microphone they are practically uniform in this respect, not only for small variations but also for great; thus it becomes possible to transmit loud tones without confusion and loss of definition, and thereby to increase the distance attainable in long transmissions.

The mouthpiece is covered with a disk of varnished silk *i* or similar material, to preserve the front contacts from deterioration through moisture, &c.—*L'Industrie Electrique.*

Wireless Telegraphy.—It has been announced that the German station at Nauen has succeeded in maintaining wireless communication with the North-German Lloyd steamer *Bremen* for four days out, the maximum distance attained being 1,500 miles. The Telefunken system was employed.

Wireless Telegraphy Conference.—After the opening of the Conference, on Wednesday last week, by the Secretary of State of the Imperial Post Office, the Under-Secretary (Herr Sydow) took the chair, and Mr. Babington Smith (Great Britain), Vice-Admiral H. V. Manney (United States), and M. de Szalay (Hungary) were elected vice-presidents. The Conference then drew up a scheme for the order of its proceedings, which are being conducted in private.

It is reported by the *Tribune* correspondent that, at the opening sitting, the German Government endeavoured to obtain an agreement to the effect that a simple majority of votes should suffice to pass any proposal—a course of procedure which would undoubtedly have enabled the German interests to gain their ends in spite of Great Britain and Italy.

The German Press continues to agitate for the abolition of the predominant position acquired by the Marconi Co., on the score of the strategic and commercial advantages enjoyed by the United Kingdom as a result of British control of the world's wireless telegraph system.

Various rumours have been reported in the London daily Press as to dissensions between the British delegates, the isolation of Great Britain, her hearty support by Italy, France, Japan, &c.; really, however, nothing is known as to the proceedings, and these "reports" are of no value whatever.

The delegates are to pay a visit to Hamburg to-day, and will be entertained by the local authorities.

On the 17th inst. a demonstration of the Poulsen wireless system is to be given in the presence of the delegates.

CONTRACTS OPEN and CLOSED.

OPEN.

Beckenham.—October 29th. Induced draught apparatus for the U.D.C. electricity and destructor works. See "Official Notices" October 5th.

Belgium.—October 18th. The *B. of T. Journal* states that the Antwerp Municipal authorities invite tenders for the supply of 2,400 metres of electric cable. The specification (*Cahier des Charges*, No. 1,163) relating to the contract may be obtained from the Hôtel de Ville, Antwerp. Tenders to be addressed "A Monsieur le Bourgmestre de la ville d'Anvers," to Hôtel de Ville. A deposit of £20 is required to qualify any tender. A specification may be seen at the offices of the Commercial Intelligence Branch of the B. of T., Basinghall Street, E.C.

Dundee.—October 13th. Small coal for the electricity department. Mr. H. Richardson, city electrical and tramway engineer.

Erith.—October 29th. Water tank, water-purifying and softening plant, feed pump and pipework; removal and re-erection of existing condensers, feed pumps, pipework, &c. See "Official Notices" to-day.

G.W. Railway.—October 29th. Stores for one year. See "Official Notices" to-day.

Hungary.—November 15th. The municipal authorities of Veszprem are inviting tenders for the establishment of a central electric lighting station in the town.

Italy.—October 23rd. The General Direction of the Arsenal at Spezia is inviting tenders until the 23rd inst. for the supply of a large quantity of electrical cable and wire.

Johannesburg.—October 15th. Tenders are required by the T.C. for single-phase A.C. motors with accessories. See "Official Notices" August 31st.

Manchester.—October 31st. One 5,000-KW. turbo-alternator complete with condensing plant, for the Corporation. See "Official Notices" October 5th.

Newport (Mon.).—October 13th. Feeder boosters, balancer, electrically-driven pumps, switchboards and instruments, for the Corporation. See "Official Notices" September 28th.

Pontypridd.—October 22nd. Cables for the U.D.C. See "Official Notices" to-day.

Portsmouth.—November 5th. Electric pumping, &c., plant in connection with the works for the prevention of storm water flooding at Southsea. See "Official Notices" to-day.

Spain.—October 15th. The municipal authorities of Cadalso (Province of Madrid) are inviting tenders for the concession for the electric lighting of the town. Tenders are to be sent to El Secretario del Ayuntamiento de Cadalso (Madrid), whence particulars may be obtained.

Spain.—The municipal authorities of Torres (province of Jaen) are inviting tenders until the 18th inst. for the concession for the electric lighting of the town during a period of 20 years. Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamiento de Torres (Jaen).

CLOSED.

Aston.—The T.C. has accepted the tender of Callender's Cable & Construction Co., Ltd., for cables for Erdington, at £5,808.

Aston Manor.—The Electricity Department has placed an order with Messrs. Johnson & Phillips, Ltd., for an extension to the switchboard.

Bradford.—The T.C. has accepted the tender of Messrs. Saunders & Co., Ltd., for the supply of signalling apparatus for the Nidd Valley Light Railway, at £435.

East Ham.—The T.C. has accepted the tender of Mr. W. R. Reynolds, Queen Victoria Street, E.C., at £122 12s. 6d., for wiring the new hospital.

France.—The French Post and Telegraph authorities in Paris have just placed contracts as follows:—La Société Alsacienne de Constructions Mécaniques, Belfort, 315 kilometres of telephone cable (112 pairs of conductors), at £478 per kilometre; Messrs. Aubert Grenier & Co., Paris, 315 kilometres ditto, at £436 per kilometre; La Société Française des Cables Electriques, Lyons, 16 kilometres ditto, with three pairs of conductors, at £112 per kilometre.

La Compagnie Française pour l'Exploitation des Procédés Thomson-Houston has just secured a contract for 100 electric tramcars for the Compagnie Parisienne Electrique des Tramways.

Glasgow.—The Tramways Committee of the T.C. has accepted the following offers:—

Trolley poles.—Brecknell, Munro & Rogers, Ltd.
Yellow pine planks.—J. Potter & Co., Ltd.
Steel rails and fishplates.—(*a*) Bolckow, Vaughan & Co.; (*b*) the Barrow Hematite Steel Co., Ltd.
D.C.C. wire.—Caledonian Electric Wire Co., Ltd.
Three-core cable.—National Conduit and Cable Co.

Irish Exhibition.—Messrs. Arc Lamps, Ltd., have received the order for the entire lighting of the Irish International Exhibition with their enclosed arc lamps, through Messrs. Coates and Sons, of Belfast.

London.—Islington.—The B.C. in June accepted the tender of Charrington, Sells, Dale & Co. for 2,000 tons of coal for the generating station. As it subsequently appeared that the firm struck out of their tender the conditions laid down with regard to calorific value, the contract was not completed. The Lighting Committee reported last week having accepted (subject to the usual sanction) an offer from Blackmore & Co. to supply the 2,000 tons, at 9s. 3d., the same price as that quoted by Charrington & Co. in their June tender.

Battersea.—The B.C. has accepted the tender of the British Thomson-Houston Co., Ltd., to supply two 10-h.p. motors for the public washhouses, and one 5-h.p. motor for the laundry, in connection with the disinfecting station, for £126 10s.

Camberwell.—The Guardians have resolved to take their supply of electrical goods for the ensuing year from Reed's Electrical Co. and the General Electric Co.

Stepney.—The E.L. Committee received the following tenders for additions and structural alterations at the electricity works, Osborn Street, Whitechapel:—

B. E. Nightingale (accepted)	£1,666	F. & F. J. Wood	£1,298
McLaughlin & Harvey, Ltd.	1,093	A. E. Symes	1,245
F. & E. Davey	1,120	F. & T. Thorne	1,347
Patman & Fotheringham ..	1,172	Holliday & Greenwood ..	1,259
G. Barker	1,195	Thomas & Edge	1,273
Spencer, Santo & Co.	1,200	Stedman & Co.	1,380
J. Calcutt	1,220	A. N. Coles	1,567
Perry & Co.	1,224		

The B.C. has placed an order, at £150, with Messrs. Mather and Platt to put in pipes for carrying out the Archbutt-Deely process of water softening in one of the existing tanks at the generating station.

L.C.C.—The Highways Committee of the L.C.C. received the following tenders for the execution of the roadwork and platelaying in connection with the construction of tramways across Westminster Bridge and along the Victoria Embankment:—

Dick, Kerr & Co. (accepted)	£45,837	J. Mowlem & Co.	£47,771
J. G. White & Co.	46,335		

The estimate of the Council's chief engineer was £47,019. All the portions of work under the contract are now in hand. Arrangements have been made to obtain a temporary supply of power from the Underground Electric Railways Co., of London, at the rate of 1d. per unit, and this will be for a period of six months from the date of commencement of the supply.

Newcastle-under-Lyme.—The T.C. has accepted the tender of Messrs. Hornsby & Co. for the supply of two gas engines for the electricity works, at £807, and that of the Chloride Electrical Storage Co. for a battery, at £205.

Rathmines.—The District Council on 3rd inst. accepted the following, out of the 50 tenders submitted to Messrs. Hammond's specification:—

Section A.—Electricity supply mains.—British Insulated & Helsby Cables, Ltd.—£16,270.
Section B.—House fuse boxes.—British Insulated & Helsby Cables, Ltd.—£184.
Section C.—House meters.—Ferranti, Ltd.—At schedule rates.
Section D.—Extension of switchboard.—Electric Construction Co.—£480.
Section E.—Accumulators.—Tudor Accumulator Co.—£2,848.
Section F.—Battery booster.—Electric Construction Co.—£587.

Siam.—It is reported by Reuter from Bangkok that tenders to the following amounts for rolling stock on the Siamese Railway have been accepted:—Brush Electrical Engineering Co., £37,266; a German company, £19,532; a Belgian firm, £10,980.

Southport.—The T.C. has accepted the tender of the Vulcan Motor Co. for the supply of a motor tower wagon for the electricity department, at £345.

Stalybridge.—The Stalybridge, Hyde, Mossley and Dukinfield Joint Electricity and Tramways Board has accepted the tender of Messrs. Thos. Beeley & Sons, of Hyde, for the supply of superheaters.

Todmorden.—The T.C. has accepted the tender of Messrs. Glover for the supply of cables to Stansfield Hall, at £459.

Wolverhampton.—The T.C. has accepted the tender of the Electric Construction Co., Ltd., for the extension of the switchboard at the electricity works, at £207.

FORTHCOMING EVENTS.

Open to October 17th.—Engineering and Machinery Exhibition at Olympia, Kensington, W.

Saturday, October 13th.—At 3.30 p.m. Junior Institution of Engineers. Visit to the Engineering and Machinery Exhibition at Olympia.

At 2 p.m. North of England Institute of Mining and Mechanical Engineers. Meeting at Newcastle. "Practical Problems of Machine Mining," by Mr. Sam Mavor. Mr. Edwin Kenyon on "Transmission of Power by Ropes."

At 7.30 p.m. Birmingham and District Electric Club. At Colonnade Hotel, New Street. Mr. W. Langdon-Davies and Mr. F. B. O. Hawes on "Some Points about Single-phase Motors."

Tuesday, October 16th.—At 7 p.m. Junior Institution of Engineers. Annual general meeting at Westminster Palace Hotel. "The Protection of Inventions," by Mr. R. E. B. Dunbar Kilburn.

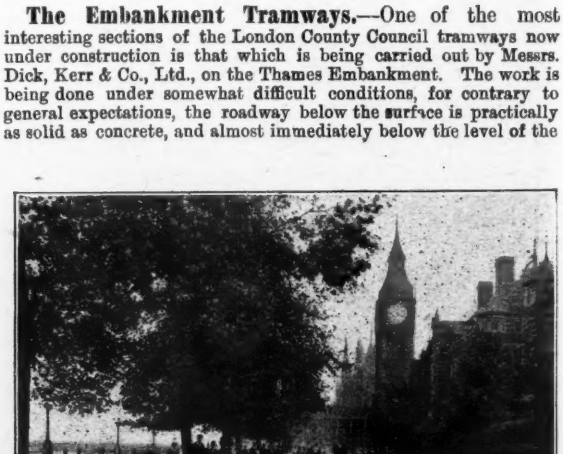
Thursday, October 18th.—At 8.30 p.m. Chemical Society meeting. Presentation of the Longstaff medal to Prof. W. Noel Hartley.

Friday, October 19th.—Northampton Institute Engineering Society. Presidential address by Dr. R. Mullineux Walmsley. Messrs. S. M. Hills and W. Chappell on "Reciprocating Engines *v.* Steam Turbines."

At 8 p.m.—I.Mech.E. First general meeting of session. Resumed discussion on "Railway Motor-Car Traffic," by Messrs. T. H. Riches and S. B. Haslam. Mr. E. M. Hann on "Some Notes on the Mechanical Equipment of Collieries."

NOTES.

The Embankment Tramways.—One of the most interesting sections of the London County Council tramways now under construction is that which is being carried out by Messrs. Dick, Kerr & Co., Ltd., on the Thames Embankment. The work is being done under somewhat difficult conditions, for contrary to general expectations, the roadway below the surface is practically as solid as concrete, and almost immediately below the level of the



The Embankment Tramways under Construction.

roadway is the arch of the underground railway. Despite these and other difficulties, however, excellent progress is being made, and the contractors expect that the track work will be completed in three to four weeks from this date. Considering that the total length of line is about 3¼ miles of single track, and that work has been proceeding only some four weeks, this rate of progress is very satisfactory. The width of the Embankment is generally about

66 ft. from kerb to kerb, and the effective width occupied by the new lines is about 18 ft. to 19 ft., which leaves a width of about 47 ft. available for ordinary vehicular traffic, this width being 10 ft. more than the width of an ordinary first-class thoroughfare. Our view shows some of the trees which have occasioned so much criticism in the daily Press recently.

Celluloid Electric Machines.—The use of celluloid varnish for coating the glass disk is recommended by Mr. C. E. Benham in *Knowledge and Scientific News* for October, in the construction of plate frictional machines of the Winter type. The effect of the varnish is to render the machine insensitive to atmospheric conditions, and to enable it to start readily without first warming it.

The Engineering Exhibition at Olympia. — On Saturday last the Patrons' Dinner was given, at which the President of the Exhibition Executive Committee, Sir W. H. White, occupied the chair. Interesting and amusing speeches were made by Sir George Bartley, Admiral Sir E. Wilmot, Col. Sir E. Raeburn, Sir E. Cornwall, M.P., and others. Some musical items also found a place in the programme. At the close, the chairman said that the exhibition had been an extraordinary success, and he emphasised the educational effect it was having upon men of the working classes, who in large numbers visited the exhibition, especially on Saturday afternoons.

Sheffield Electrical Exhibition.—Mr. S. E. Fedden, the general manager of the Sheffield Corporation Electric Supply Department, entertained Mr. Councillor Crowther, the chairman of the Exhibition Sub-Committee, and the heads of the staff of the electric supply undertaking to dinner at the Exhibition Café in the Corn Exchange on Wednesday evening, October 3rd. An excellent dinner was served by Messrs. Hollands, the caterers at the exhibition, the whole of the viands being electrically cooked, including the coffee, which was roasted by electricity. Each person present was provided with a very tasteful menu, which was designed by Mr. C. E. R. Biggin, the various items being set out in "electrical" language. Mr. Fedden stated that he had arranged this little dinner in order to show his great appreciation of the splendid way in which the whole of the staff had worked in arranging the exhibition and to celebrate the successful completion of the work. He had been congratulated on all hands on the success of the show, and the Lord Mayor had honoured the Committee by attending specially to congratulate them. He said that he had visited a large number of exhibitions in this and other countries, but had not been more interested in what he had seen anywhere than at this exhibition, and he thought it reflected great credit on all concerned. Mr. Fedden thought they could not have better testimony than that. Mr. Councillor Crowther expressed thanks to Mr. Fedden for his kindness and for the opportunity afforded him of meeting the assistants who had worked so admirably in making the exhibition such a great success, and he wished to thank all, from the manager down to the men working in the street, for the deep interest they had displayed in the work. He could not tell at this stage whether the exhibition would be a financial success, but in all other respects it was an unbounded success, and he had great hopes of the benefits which would follow as a result of this exhibition. Mr. J. W. Beauchamp, deputy manager, seconded, on behalf of the staff, the vote of thanks to Mr. Fedden. The great amount of extra work which the exhibition involved had been a duty of pleasure to them. He stated that not the least interested visitors to the exhibition were the school children who visited the show in charge of their teachers during the afternoon by arrangement with the Education Commitee. They were taken round in small parties in charge of different members of the staff, who carefully explained the different apparatus to them, and the children had taken great interest in everything that had been shown to them.

High Pressure Transmission in Italy.—The Felten and Guilleaume-Lahmeyer Works Co. is reported to have concluded an agreement with the Società Industriale Italiana, of Rome, for the carrying out of a large water-power installation involving 18,000 H.P. on the Tronto in the neighbourhood of Ascoli-Piceno. The hydro-electric plant is to be used for electrical transmission at from 40,000 to 50,000 volts, and the energy is to serve for electro-chemical purposes. It is claimed that this represents the highest pressure in use in Europe for any installation of a similar kind. The German company in question states that the orders received in the first nine months of the present year are 25 per cent. greater than in the equivalent period of 1905 at the Carlswerk department at Mulheim, and 60 per cent. greater at the dynamo works at Frankfort. On the whole, the prices obtained are declared to be more satisfactory than a year ago.

The Danger of Falling Wires.—A peculiar case has just been decided at Hamm, in Westphalia. It appears that a merchant was struck by a falling trolley wire of a tramway and received severe injuries from electrical shock. He, thereupon, instituted an action against the tramway company for damages, and claimed the payment of £1,000 per annum on the ground that he had suffered greatly from the shock, and had not recovered from it, and that it would be impossible for him to follow any intellectual employment. The company disputed its liability, inasmuch as the accident did not occur in the working of the tramway, and also because there was no question of any fault on the part of a person employed by the company. When the case came before the Land Gericht, the latter held that the claim of the complainant was justified, and the company's subsequent appeal to the Oberland Gericht of Hamm was rejected as being unfounded. The Hamm Court held that the company was responsible for all the disadvantageous consequences arising to the complainant out of the accident. The company used electricity as a means of working, and the high pressure of the electric current represented one of the dangers incidental to the working of an electric tramway.

Institution and Lecture Notes. — *Northampton Institute Engineering Society.*—The opening meeting will be held on Friday, October 19th, when Dr. R. Mullineux Walmsley will deliver a presidential address, which will be followed by a debate on "Reciprocating Engines *v.* Steam Turbines," opened by Mr. S. M. Hills and Mr. W. Chappell for the respective sides.

On October 3rd Prof. H. Wilson delivered the inaugural lecture of the session to the students of King's College, London, his subject being the electron theory.

The University of London has started a three years' course of public illustrated lectures on the "History of Architecture," by Mr. Banister Fletcher, F.R.I.B.A. The lecture on "Egyptian Architecture," illustrated by lantern slides, was delivered on Monday last in the University Buildings, Imperial Institute Road, South Kensington, S.W.

Motor-Omnibuses in Manchester.—The Hackney Carriage Committee of the Manchester City Council has unanimously decided that the licences of motor-omnibuses, which expire on the 16th inst., shall not be renewed. The omnibuses are held to have created a nuisance in the suburbs and, as at present built, to be unfit to run on the roads.

The Brush Strike.—According to the *Tribune* the men out on strike at the Brush Electrical Co.'s works at Loughborough have agreed to a settlement of the dispute by arbitration, and Mr. J. J. Steinitz, the manager of the works, has been approached with a view of obtaining an agreement from the firm.

Marylebone Council Fined. — On Wednesday the Marylebone Borough Council was fined in all £60 10s., including costs, for having failed, on several days in September, to maintain an efficient supply of electricity to the premises of Messrs. Mappin and Webb, Ltd., of Oxford Street, W.

"Zone" Patents.—The following letter comes to hand too late for insertion in our "Correspondence" columns:—

"We notice in the technical papers an announcement by Mr. H. F. Joel to the effect that he is the patentee of the 'Zone' patent electric motor. As this may lead to some confusion, we beg to say that while Mr. Joel may be the inventor of *a* motor, the machine we are making under the licence of the Zone Dynamo and Motor Patents Co. is, we believe, the only 'Zone' machine now being made, and is the invention of our chief electrician, and not that of Mr. Joel.

"We should feel obliged if you would give publication of this announcement.

"NEWTONS LTD.,
"H. N. HICKLEY, *Manager.*

"Taunton, *October 9th*, 1906."

The International Commission on Units.—The *Electrical World* says that Prof. H. S. Carhart, who was given leave of absence by the Board of Regents of the University for a year in order to enable him to attend the sessions of the International Commission on Electrical Units and Standards to be held next month in London, "will not be obliged to take advantage of the absence on account of the postponement of the sessions for a year."

Electrical Manufacturers and the Irish International Exhibition, 1907.—We learn that the Committee of the National Electrical Manufacturers' Association (Incorporated) has considered the question of next year's exhibition, and has decided that the embargo established against electrical exhibitions shall be waived on this occasion. Members of the Association are, therefore, at liberty to exhibit at the said Exhibition if they think fit.

For Sale.—Messrs. Percy Huddleston & Co. will, on October 18th, sell various electrical apparatus and fittings by auction at Manchester.

Messrs. Wheatley Kirk, Price & Co. will, on October 31st and November 1st and 2nd, offer for sale by auction the land, buildings, plant, machinery, and other contents of the works of the Goodfellow Engineering Co., Ltd. (in liquidation). Particulars may be found among our advertisements to-day.

Particulars are also given of an auction sale to be conducted at Leeds on October 22nd, 23rd and 24th by Messrs. Whitham & Sons (*re* Wharam & Borland dissolution).

Educational Note.—A "Student's Handbook" issued by the Education Department of Blackburn Corporation gives particulars of the facilities for secondary education provided by the authority. A complete course in Electrical Engineering is drawn up, embracing allied subjects such as drawing, mathematics, mechanics, &c., without which no real benefit can be derived from the instruction given. Mr. P. M. Hampshire is the lecturer in Electrical Engineering.

Appointment Vacant.—Shift engineer for the Warrington electricity department (45s.).

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the Electrical Review *posted as to their movements.*

Central Station Engineers.—The staff of the Ilford electricity works presented Mr. J. A. Lee with a beautiful gold albert on Monday last, on the occasion of his leaving to take up an appointment as charge engineer at the Stepney electricity works.

Mr. Archibald Page, chief assistant engineer of the electricity department of the Glasgow Corporation, is to be married on the 17th inst. To celebrate the occasion his colleagues in the electricity department entertained Mr. Page to dinner in the Grosvenor Restaurant, Glasgow, on Monday, October 1st. The chief engineer, Mr. W. W. Lackie, presided, and was supported by Mr. W. A. Chamen, late chief engineer of the department, and now general manager of the South Wales Electric Power Distribution Co., who journeyed from Cardiff for the occasion, and proposed the toast of the evening. Messrs. MacCall, Paterson and Cairns acted as croupiers. Mr. Page joined the staff of the electricity department in Glasgow eight years ago, and has been steadily promoted until he has reached his present position.

With reference to our note of last week concerning Bridlington, we learn that Mr. A. J. Beckett, the borough electrical engineer, has declined the £20 grant of the Council.

Mr. W. J. S. Jones has resigned the position of resident engineer to the Durham Collieries Electric Power Co., Ltd.

On the 10th inst., the marriage took place of Mr. W. J. Leeming, the electrical engineer to the Buxton U.D.C., to Miss Eva Campbell, youngest daughter of the late Deputy Inspector-General G. A. Campbell, R.N., of Buxton. Among the presents was a solid silver-fitted suit case, from the staff at the works.

General.—Mr. A. L. Curling, local manager at Rochester and Chatham for the National Telephone Co., who is leaving for Tunbridge Wells, has been presented by the staff with a gold-mounted umbrella, walking-stick, and framed photograph of the staff.

Mr. James Livingston, assistant superintendent of telegraphs in Glasgow Post Office, has been appointed chief superintendent of the telegraph department at Leeds, and entered upon his new duties yesterday (Thursday). Mr. Livingston has been 36 years in the service, and has passed through all grades. For some years he was engaged as lecturer on telegraphy and telephony in the Glasgow and West of Scotland Technical College.

As our readers are already aware, Mr. John F. C. Snell, M.Inst.C.E., M.Inst.E.E., M.Inst.Mech.E., Past-President of the Incorporated Municipal Electrical Association, will resign the position of chief electrical and tramways engineer to the county borough of Sunderland at the end of the present year. He has been retained as joint consulting engineer in the London County Council Power Bill, and will shortly commence to practise at Caxton House, Westminster, as a consulting electrical engineer. He has taken into partnership Mr. Stuart S. Moore Ede, who has had considerable experience in railway and tramway work in America and in the East. Messrs. Snell & Moore Ede will be prepared to undertake Parliamentary work, arbitrations, engineering valuations and assessments; to give expert advice upon power, railway and tramway work, and the application of electricity to industrial purposes.

Obituary.—The death occurred on October 2nd, at Edinburgh, of Mr. George Sinclair, boiler-maker, Albion Boiler Works, Leith. Mr. Sinclair was just putting a new patent water-tube boiler on the market. The business will be continued by two of the deceased gentleman's sons.

NEW COMPANIES REGISTERED.

Electric Vehicles Development Co., Ltd. (90,213).—This company was registered on September 22nd, with a capital of £1,000 in £1 shares, to carry on the business of motor-car, landaulet, cab, omnibus and van proprietors, carriers of passengers and goods, electric and other motor manufacturers, &c. The first subscribers (each with one share) are:—B. F. Lironi, 19, St. George's Avenue, Forest Gate, E., clerk; P. Atkins, 12, John Street, Bedford Row, W.C., clerk; W. Nendick, 62, Kingswood Road, Clapham Park, S.W., agent; F. S. Littlejohn, 85, Gracechurch Street, E.C., accountant; W. T. Harrison, 85, Gracechurch Street, E.C., accountant; A. J. Faulkner, 38, St. John's Park, Blackheath, S.E., accountant; and L. E. P. D'Argrond, 52, Waldemar Avenue, Fulham, S.W., engineer. No initial public issue. The number of directors is not to be less than three or more than five; the first are H. B. Van Daalen, G. Breffit, F. Griffiths, and H. F. L. Pilet; qualification, one share; remuneration as fixed by the company. Registered office, 149, Bishopsgate Street Without, E.C.

Ystradgynlais Electric Light Co., Ltd. (90,178).—This company was registered on September 19th, with a capital of £3,000 in £1 shares, to generate, store, accumulate and distribute electricity and electro-motive power for lighting streets and public or private buildings and places, or for any other purpose, &c. The first subscribers are:—Rev. W. M. Morgan, Manoravon, Ystradgynlais, Brecon, 100 shares; E. E. Watkins, Royal Stores, Ystradgynlais, Brecon, grocer and draper, 25 shares; T. Williams, London House, Ystradgynlais, Brecon, attendance officer, 25 shares; O. D. Jeffreys, Gough Buildings, Ystradgynlais, Brecon, general haulier, 25 shares; T. Evans, Ystradgynlais, Brecon, engineer, 50 shares; E. Williams, Pantyffynon Cottage, Ystradgynlais, Brecon, boot dealer, 25 shares; and T. T. Rees, Ardwyn, Ystradgynlais, Brecon, schoolmaster, 25 shares. Minimum cash subscription, half the shares offered to the public issue. Registered without articles of association.

CITY NOTES.

Willans & Robinson, Ltd.

The annual meeting of the shareholders of this company was held on Wednesday last week at the Cannon Street Hotel, Mr. Mark Robinson presiding.

The Chairman, in proposing the adoption of the report (see Electrical Review, September 28th), said that, notwithstanding some misapprehensions on the subject, he was glad to be able to congratulate the shareholders on the progress of the company's business and on the fact that they had at last reached that long-expected point—the turning of the corner. The one matter which was of supreme importance to them was the ability of the Rugby business to earn good profits in the future. As far as concerned the work now going on, and that which appeared to be lying before them, and apart from the clearing up of old troubles, or of new troubles which had developed out of old transactions, he did not think that shareholders could desire a wholesomer or sounder or more promising business than that to which they were now devoting themselves. Even its volume gave no cause for complaint, for the number of men employed at Rugby was now considerably larger than it was in their best days, and the volume of their work there showed no diminution, but a great increase over that of the past two years. They might think that he had referred too lightly to the clearing up of old troubles, but he thought he would show them that the losses they involved and which they deplored had not a great bearing upon their ability to make profits in the future. They were, indeed, great losses which they had to face, and they were not hidden in the report. They desired to deal with these losses through a suspense account until the hoped-for disposal of the Queen's Ferry works enabled the whole losses of the company to be dealt with at once. The Queen's Ferry loss was now no more than about £2,300 in excess of the depreciation written off, and even that excess was less than the amounts charged to Queen's Ferry as its proportion of the debenture interest and directors' salaries. As there might be litigation in connection with some of the losses, detailed figures or explanations were inadvisable. The most serious single item was a loss which was plainly coming upon them in regard to one of the large electric power companies whose debt they must treat as bad, though there was a suggestion to pay it in shares for which a future value was claimed. They also held a few of that company's shares, and those they must for safety write down to a nominal value. That was one of the cases where they took important contracts under the condition that they would accept payment of a certain proportion of the purchase money in shares. The arrangement had been unfavourably commented upon at their meetings, and loss had been freely predicted, but except to a very small amount they had lost nothing upon the shares received in payment from the company in question. The loss they would suffer arose upon the cash part of the contract in respect of payments which fell into arrear, and which the Power Co. was now unable to make. The circumstances were very complicated, and it would be impossible to lay them fully before the meeting, but when he told them that only a year ago they sold quite a number of the shares on quite advantageous terms, they would realise that at the date of the last balance-sheet they had little reason to feel that their debt would not be paid. All the power companies were by no means in the same position, but they had thought it proper to write down to nominal values all shares which they held in other undertakings. It would be seen, therefore, that though they had lost no time in bringing forward these various matters as losses, the amounts were not in all cases realised or ascertained losses, but might be regarded to some extent as reservations for prudence' sake, which might not all turn out quite so bad as they looked. There were two other things to be pointed out about these losses. One was that so far as they arose from contracts with power companies, large as the losses were, there had been no loss over the contracts as a whole. The contracts were for very large amounts, and as they were reasonably profitable contracts, the profits on the earlier portion of the contract exceeded the losses, which had arisen only in the final winding-up of the accounts. Another, and very important, thing to be pointed out was that much of the loss had no effect upon the financial strength of the company. So far as it represented outlay in the past, upon patents and experiments, and the like, the only change was that this outlay would no longer figure as an asset. As regarded the shares written down, only a portion were shares taken in payment under contracts. Some were held by them as a pledge of business with the companies concerned, while a further considerable number came into their hands as bonuses for which they paid nothing. To a large extent these shares had no pretence to the quality of a liquid asset. As regarded expected losses under "debtors," the case was different; were these amounts paid to them they would, of course, be available for the general purposes of the company. But the precautions which had been taken throughout these difficult times to keep the company in a financially strong position enabled them to bear this added trouble. Their boast that, bad as their case was, they had a strong position financially, was well-founded. They were accustomed to prepare estimates for some months ahead, of their probable expenditure and probable receipts, and they had been so much on the side of prudence that their ability to carry on the company was not affected by any of the losses in question. It might surprise some shareholders to learn that for over two years—the years in which some of their friends supposed they had been sinking into rapid ruin—they had never had an overdraft at their bankers. Reference was made in the report to their intention not to proceed with the once contemplated business of building large gas engines; this was, of course, the reason for writing off as an

immediate loss a good deal of expenditure which it would otherwise be reasonable to write off over a term of years. In the steam turbine business they had a more promising employment for their capital and plant than could ever be supplied by gas engine construction. But there was another reason, in the manufacture of the Diesel oil engine, which, as they had stated before, had been undertaken by the company, and which they thought was likely to employ them so fully that they would have no wish, or need, to think further about gas engines. The first batch of Diesel engines should be completed before the end of the year. They believed this would prove to be one of the most valuable developments of the internal combustion engine. Before concluding, he would like to say a few words on the ill-understood subject of depreciation, and upon its effect on their accounts. He would limit what he had to say to the case of Rugby. They moved to Rugby in the spring of 1897, so there were 9½ complete years to consider. In that time they had written off as depreciation on freehold premises and buildings, on plant and machinery, and on patents and experiments, the total sum of £120,009. They had fully maintained their buildings and plant in perfect condition out of revenue—in fact, in the 9½ years they had spent no less than £69,426 upon repairs and renewals. On the other hand, there was depreciation, which represented a real fall in value. Parts of buildings were pulled down to make way for additions, or temporary buildings were removed altogether. The advantage derived from money spent on patents and experiments, however beneficial, could not endure more than a few years, so, in their case also, writing down represented true fall in value. Searching back through the past accounts he had endeavoured to separate the items which represented the undoubted loss upon such things as the foregoing. After allowing for those real drops in value or extinctions of value, a sum of at least £50,000 remained, which was, he assumed, depreciation in 9½ years, of property which had been most thoroughly kept up out of revenue, and it was quite open to question whether this assumed fall in value, which they had treated as a real loss—that was, had charged against their profits, had a real existence, at any rate, to so large an amount. So long as Rugby was a "going concern"—and it was never more so than now—it might be doubted whether it and its contents were not a good deal under-valued in the accounts—if not to the extent of £50,000, then to the extent of a large proportion of that sum. Their freehold included, for instance, about 40 acres of land, which cost them on an average £250 per acre. Land adjoining their works had sold for building (after roads and drains have been provided) for nearer £1,200 per acre, and that alone suggested that Rugby was worth a good deal more than the balance-sheet showed. They must not think that they repented in the smallest degree having thus written the property down. The strong position of the company, under blows which many might have thought could not be survived, was largely due to the great prudence exercised in this matter in the past, and that was why they were able to stand before them to-day with small fears and large hopes for the future.

Sir Gilbert A. Clayton, in seconding the motion, appealed to the shareholders to do or say nothing which would at all interfere with the sale of the works at Queen's Ferry, which would interfere with their growing business.

Mr. Walter Stewart said that in 1900 the capital of the company was £723,326, to-day it was £1,092,829. The debenture interest in 1900 was £100,000; it had since been increased to £246,000. The salaries and remuneration to directors in 1900 were £6,452, to-day they were £9,577. The gross profit in 1900 was close upon £51,000, to-day it was only £27,746, and while in 1900 the profit available for dividend was £26,303, to-day there was a loss of £6,535, and the reserve fund had shrunk from £55,646 to £21,150. There was no doubt that all the trouble was owing to Queen's Ferry, and he asked the shareholders whether in view of the figures they had been presented with that day, the chairman was justified in the optimistic view he took of things.

Mr. Leefe said he hoped the shareholders would give the directors a little more time. He was at Rugby a few months ago, and was very much struck with the amount of work being done there. Queen's Ferry was a gamble, and the shareholders must face the fact that they had lost their money; certain it was that it would not help them to regain it by putting difficulties in the way of the directors selling it.

Mr. George W. Anderson, who is in charge of Queen's Ferry, said his firm belief was that there was a very valuable business there which only needed working up.

After further discussion, the report was adopted by 32 votes to 17.

Cuba Submarine Telegraph Co., Ltd.

The directors' report for the half-year ending June 30th, 1906, says that the total receipts of the six months were £19,098, while the expenses amounted to £6,404, leaving a balance of £12,694, to which has to be added £5,604 brought forward from last account, giving a total of £18,298 to be dealt with. The sum of £5,000 has been added to the reserve fund, which now stands at £92,000. The dividend on the preference shares will absorb £3,000, and leave £10,298, out of which the directors recommend the payment of a dividend at the rate of 5 per cent. per annum on the ordinary shares, free of income-tax (as in 1905); the balance, £6,298, being carried forward to the current half-year. Since the close of the half-year a rising has taken place in Cuba resulting in the intervention of the United States Government. Some slight damage has been done to the company's property, but the cables have not suffered in any way and continue in good working order.

Monte Video Telephone Co., Ltd.

The directors' report for the year ending July 31st last shows after providing for all working expenses in Monte Video and London, a net profit for that period of £17,295, as against £15,473 for the previous year. On May 1st last the directors paid interim dividends of 2½ per cent. on the preference share capital, and 2 per cent. on the ordinary share capital, which absorbed the sum of £3,615 18s. After providing for the interim dividends there remains a balance of £13,679, and to this amount should be added the sum of £2,047, brought forward from last year, making an available balance of £15,726. After transferring £5,000 to reserve fund, and £4,000 to reserve for renewal of plant, the directors recommend the payment of final dividends of 2½ per cent. upon the preference share capital, and 3 per cent. upon the ordinary share capital, leaving a balance of £2,383 to be carried forward. There has been a continued increase in the number of subscribers, and a proportionate increase in the receipts for the year. Last year 4 per cent. was paid on the ordinary shares.

Swansea Improvements and Tramways Co.—The report for the half-year ended June 30th last states that the gross receipts from the tramway undertaking amounted to £21,703, an increase of £4,952, and expenses to £18,512, an increase of £6,059. The expenses include debenture and other interest, and provision for the estimated amount payable to the Swansea Corporation in respect of the tramways and light railways constructed by the Corporation, which are at present being worked by the company in anticipation of the lease to be granted. For the half-year there is a total of £4,999 at credit of profit and loss account. The directors propose to place to reserve and depreciation fund £1,000, and after paying preference dividend, there will remain to be carried forward £2,700. The total capital expenditure of the Corporation in respect of the tramways and light railways constructed by them has now been agreed, and it is anticipated that the yearly amount payable by the company in respect thereof will be settled shortly and the leases executed. In order to cope with the increased traffic requirements, an arrangement has been made with the B.E.T. Co., Ltd., for the provision of 10 new cars, payment for which is to be spread over a series of years, the first instalment being payable on January 1st next.

Clyde Valley Electrical Power Co.—The half-yearly general meeting was held at Glasgow on Thursday last week, Sir David Richmond presiding. The directors' report for the period from January 1st, 1906, to June 30th, 1906, stated that in terms of the remit made to the directors at the last meeting, Mr. Newcomb Carlton, 2, Norfolk Street, Strand, London, had been appointed a director of the company. Contracts for the supply of power to the extent of 9,382 H.P. had now been made, including contracts with Yarrow & Co., Ltd., the Coventry Ordnance Works, Ltd., and William Beardmore & Co., Ltd. It was estimated that the above figures would represent the consumption of 10 million units per annum, and it was hoped that the necessary connections would be made by the end of the present year. The quantity of energy sold for the last half-year amounted to 358,312 units, as compared with 154,873 units for the previous half-year. The report was adopted.

Stock Exchange Notices.—Applications have been made to the Committee to appoint a special settling day in and to grant a quotation to:—

De Mello Brazilian Rubber Co., Ltd.—175,000 7 per cent. participating cumulative preference shares of £1 each.

And to allow the following securities to be quoted in the Official List:—

Babcock & Wilcox, Ltd.—Further issue of 30,000 ordinary shares of £1 each, fully paid.

Ibbotson Bros. & Co., Ltd.—The thirty-fourth annual report of the directors states that the profit for the year ended June 30th last amounts to £19,691, to which has to be added £9,571, brought forward from the previous year. The directors recommend that a final dividend at the rate of 10 per cent. per annum, free of income-tax, for the half-year ended June 30th, making 7½ per cent. for the year, be paid on November 1st next; that £5,000 be added to the reserve fund, and that the balance of £8,798 be carried forward.

Indo-European Telegraph Co., Ltd.—The directors have declared an interim dividend for the half-year ending June 30th last at the rate of 5 per cent. per annum (as in 1905), free of income-tax, payable on and after November 1st next. The transfer books will be closed from the 18th to the 31st inst.

Anglo-American Telegraph Co., Ltd.—The board has resolved to declare an interim dividend for the quarter ending September 30th, 1906, of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, less income-tax, payable on November 1st.

Direct United States Cable Co., Ltd.—The board has resolved upon the payment of an interim dividend of 4s. per share, free of income-tax, being at the rate of 4 per cent. per annum, for the quarter ending September 30th, 1906, such dividend to be payable on and after the 26th inst.

Geneva Tramways Co., Ltd.—This company on 4th inst. confirmed resolutions passed at a previous meeting approving a scheme to sell the undertaking to a new company.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Fortnight ended.	Receipts for the fortnight. £	Receipts for the fortnight. £*	No. of wks.	Total to date. £	Total to date. £*	Route miles open.	*
Aberdeen	Oct. 3	4,849	+1,980	18	29,671	+ 1,887	14·4	..
Ayr	Sep. 29	1,209	+ 111	20	8,440	+ 188	8	..
Bath	Oct. 3	1,871	+ 348	40	33,869	+ 6,174	13	..
Belfast	,, 5	7,172	+2,756	40	132,376	+41,606	40	+ 6½
Birkenhead	,, 7	2,268	+ 178	27	29,652	+ 537	13·52	..
†Blackburn	,, 3	1,128	— 28	27½	29,773	+ 1,802	13·62	..
Blackpool Corp.	,, 4	3,031	+ 593	25	44,019	+ 3,064	11·87	..
,, —Fleetw'd	,, 6	1,866	+ 575	14	21,003	+ 3,223	8·25	..
† ,, —Lytham	Sep. 2	825	+ 155	39	12,897	+ 1,353	7½	..
Bolton	Oct. 7	4,291	+ 509	27	59,387	+ 4,464	26	+ 1
Bournemouth	,, 3	3,517	+ 641	26½	49,825	+ 9,940	18·75	+6·7
†Bradford	Sep. 29	4,645	+ 257	26	123,144	+ 5,003	53	+ 2
Brighton	Oct. 6	2,012	+ 98	27	30,254	..	9·5	..
Bristol	,, 5	10,479	+ 862	..	..	..	28·5	..
Brit. Elec. Trac. Co								
Airdrie	Sep. 28	472	— 7	39	8,653	+ 682	3·65	..
Barnsley	,, 28	326	— 11	,,	6,395	+ 89	..	..
Barrow	,, 28	570	+ 33	,,	10,293	+ 656	5·37	..
Cavehill	,, 28	247	+ 147	,,	3,724	+ 1,657	..	..
Devonport	,, 28	976	+ 16	,,	18,077	— 142	8·85	..
Gateshead	,, 28	2,009	+ 86	,,	37,858	+ 2,028	11·25	..
Gravesend, N'fleet	,, 28	515	+ 9	,,	9,647	+ 420	6·5	..
Greencck	,, 28	1,584	+ 75	,,	26,778	+ 1,357	7·25	..
Hartlepool	,, 28	611	+ 26	,,	12,024	+ 1,506	6·72	..
Kidderminster	,, 28	230	— 41	,,	4,900	— 35	..	..
Leamington	,, 28	364	— 22	,,	7,029	+ 2,640	3	..
Merthyr	,, 28	417	+ 39	,,	7,700	+ 240	2·9	..
‡Metropolitan	,, 28	7,005	+ 726	,,	134,951	+30,771	22	..
Middleton	,, 28	714	+ 8	,,	14,129	+ 577	8·5	..
Mid. Joint Com'tee	,, 28	19,616	—1,144	,,	396,520	+16,635	..	..
Oldham — Ashton	,, 28	1,173	— 20	,,	22,361	+ 559	9·13	..
Peterborough	,, 28	255	— 13	,,	5,190	— 314	5·31	..
Potteries	,, 28	3,701	+ 94	,,	69,195	+ 3,307	29	..
Rothesay	,, 28	666	+ 66	,,	10,353	+ 1,583	2·75	..
Southport	,, 28	726	+ 79	,,	13,163	+ 396	8·17	..
†S. Metropolitan	,, 28	481	..	39	10,804	..	..	..
Swansea	,, 28	1,770	+ 109	39	32,954	+ 5,057	5·5	..
Tynemouth	,, 28	547	+ 50	,,	10,817	+ 106	3·75	..
Weston-s-Mare	,, 26	430	+ 55	,,	6,898	+ 532	3	..
‡Worcester	,, 28	624	— 28	,,	11,373	— 835	5·75	..
Wrexham	,, 28	226	+ 18	,,	4,104	+ 92	..	..
Yorks. Wool. Dist.	,, 28	1,935	+ 462	,,	35,553	+10,114	17	..
Miscellaneous	,, 28	223	+ 85	,,	4,218	— 497	..	..
Burnley	Oct. 6	2,586	+ 229	39	..	..	7·5	..
Burton-on-Trent	,, 6	620	+ 23	27	8,502	— 451	9·5	+ 1
Bury	Sep. 30	2,101	..	26	26,667	..	10·5	..
Cardiff	,, 29	4,529	+ 200	26	56,561	+ 176	15·87	..
Carlisle	Oct. 6	389	+ 12	40	7,554	+ 29	..	..
Chatham and Dist.	,, 4	1,756	+ 435	40	27,657	+ 721	12·84	+ 3·5
Cork	,, 4	1,063	+ 24	40	19,636	— 189	9·89	..
Croydon	,, 5	2,281	+ 458	18	29,008	+ 2,366	11·25	+ ·5
Darlington	Sep. 29	421	+ 15	26	5,667	+ 196	4·87	..
Darwen	Oct. 5	589	+ 36	27	7,055	+ 316	4·96	..
Dover	,, 6	525	+ 40	27	7,795	+ 1,111	4·75	+ 1½
Dublin	,, 5	10,156	+ 567	14	79,629	+ 4,467	48·75	+ ·25
Dundee	,, 3	2,337	+ 299	20	22,943	+ 4,508	13	+ ·5
East Ham	,, 6	1,883	+ 211	27	25,777	+ 2,379	8	+ ¼
Exeter	,, 5	686	+ 176	27	8,501	— 147	4·75	+ ·5
Glasgow	,, 6	36,644	+3,668	21	314,624	+28,290	81·75	+ 6
†Halifax	Aug. 29	1,760	+ 89	22	38,419	+ 1,044	37	+ 1·5
Hastings	Oct. 5	2,004	..	..	..	..	..	..
†Huddersfield	,, 6	1,581	+ 229	27	42,448	+ 3,991	23	..
Hull	,, 6	4,611	+ 295	27	61,632	+ 1,536	13	..
Ilford	Sep. 22	960	+ 28	24	12,522	+ 211	6·37	..
Ilkeston	Oct. 3	274	+ 49	27	3,777	+ 491	3·5	..
Ipswich	,, 6	879	+ 65	27	12,955	— 78	10·5	..
Isle of Thanet	,, 6	1,205	+ 250	40	29,093	+ 22	11	..
†Kilmarnock	,, 6	173	+ 25	21	3,472	— 32	4·25	..
†Kirkcaldy	Sep. 26	296	+ 85	..	..	..	7·5	..
†Lan'kshire Trm. Co.	,, 27	1,024	+ 67	39	34,405	+ 5,906	12·56	+ ½
Leeds	,, 29	12,513	+ 631	26	167,579	+ 9,654	96	+ 6½
Leicester	Oct. 6	4,473	+ 352	40	..	..	..	..
Leith	Sep. 29	1,672	+ 169	20	10,831	+ 4,754	6	+ 1
Liverpool	,, 29	22,045	+ 764	39	421,078	+ 7,646	104	+ 1
†‡L.C.C.	,, 22	24,788	..	25	661,799	..	98¼	+·47
London United	Oct. 5	12,671	+2,114	40	253,487	+18,659	..	..
†Lowestoft	Sep. 30	242	+ 38	52	9,901	— 416	3·5	..
Manchester	Oct. 6	29,398	+3,845	22	379,561	+25,681	146	+21
Newcastle	,, 6	8,156	+ 578	27	104,023	+ 7,131	25·5	..
Newport	Sep. 30	1,326	+ 185	26	17,149	+ 1,093	14·5	+ 1·5
Northampton	Oct. 5	938	+ 87	27	12,740	+ 285	5·5	..
Oldham	,, 7	3,819	+ 544	28	51,775	+ 5,168	28·75	..
Pontypridd	,, 6	342	+ 39	27	4,654	+ 126	3·5	..
Portsmouth	,, 6	4,036	+ 554	27	61,048	— 118	14·5	..
Preston	,, 3	1,502	+ 254	..	..	..	10	..
Reading	,, 4	1,315	+ 44	27	17,858	+ 65	7·5	..
Rochdale	,, 6	2,119	+ 497	26	29,672	+ 8,307	20·6	..
Rotherham	,, 4	990	+ 40	27	13,864	+ 1,248	9·33	..
Salford	,, 1	9,429	+ 762	26	120,928	+ 3,280	38·9	..
Sheffield	,, 7	10,844	+ 912	28	149,586	+ 9,857	35·75	+ 1½
Southampton	,, 3	2,020	+ 93	26½	27,602	+ 330	..	..
Southend-on-Sea	,, 3	882	+ 132	27	12,958	+ 690	6	..
Stockport	.. ..	..	..	..	..	..	..	..
Sunderland	,, 7	2,750	+ 290	27	39,892	+ 2,273	10·87	..
Swindon	.. ..	..	..	..	..	..	..	..
Tyneside	,, 6	948	+ 166	40	18,401	+ 1,565	8·87	..
Walthamstow	,, 6	1,180	+ 305	27	17,599	..	10	..
West Ham	,, 4	4,658	+ 533	27	62,826	+14,555	14·7	+ 1·4
Wolverhampton	,, 3	1,717	+ 119	27	23,436	..	12·5	..
Yorks. W. Riding	,, 7	1,662	+ 147	40	33,487	..	..	..
Baker St.-Waterloo	,, 6	3,225	..	14	19,465	..	4	..
Cen. London Rly.	,, 6	12,591	— 548	14	78,478	— 3,433	6	..
City & S. Lon. Rly.	,, 7	5,591	+ 323	14	35,214	+ 2,087	6·25	..
Dublin-Lucan Rly.	,, 5	259	+ 12	14	2,005	— 39	7	..
G. N. and City Rly.	,, 6	3,546	+ 248	14	22,366	+ 1,611	3·5	..
L'pool Overh'd Rly.	,, 7	2,840	+ 13	14	21,572	— 562	6·7	..
Mersey Railway	,, 6	3,467	+ 299	14	23,114	+ 1,759	4·5	..
Metropolitan Rly.	,, 7	30,317	..	14	202,841	..	70·5	..
Met. District Rly.	,, 7	16,007	+ 979	14	102,801	+ 9,963	24	..
Anglo-Argentine	,, 7	32,070	+3,996	40	596,511	+66,599	43	..
§Auckland	Sep. 14	9,710	+ 771	36½	90,006	+ 6,032	18·64	..
§Brisbane	,,	11,579	+ 995	..	..	..	..	..
§Brit. Columbia Rly.	Aug.	23,139	+2,982	8½	44,379	+ 5,740	..	..
Bu'n's A'r's E.T.Co.	Sep. 8	2,805	+ 177	36	48,840	+ 7,607	24	..
Bu'n's A'r's-Blgr'no	,, 30	7,569	— 200	39	14,021	+ 6,419	..	..
Calcutta	Oct. 6	6,078	— 163	..	..	..	..	..
§Cape Electric T. Ld.	..	..	..	..	..	..	..	..
§Geneva	Aug.	8,952	+ 352	..	..	..	..	..
§Kalgoorlie, W.A.	Sep.	4,196	..	39	38,998	..	20·5	..
Madras	,, 30	871	+ 121	39	17,068	+ 1,857	10·5	+1½
§Mexico	,,	74,400	..	..	..	..	..	..
Perth (W.A.)	Oct. 5	2,725	+ 17	40	88,163	+ 5,376	24·25	+5

* Compared with the corresponding period of 1905. † One week only.
‡ Includes horse, steam and other receipts. § One month.

STOCKS AND SHARES.

Tuesday Afternoon.

FALLING markets are as plentiful as the October blackberries, and the stringency in Lombard Street acts unfavourably in almost every direction. In the general malaise it was not likely that the electrical departments would escape, and prices have sympathetically declined in conjunction with hundreds of others round the Stock Exchange.

Labour trouble on the Clyde spread fears of what might happen further south. First it was the railways that suffered in price; then the iron and steel companies, now it is electrical supply undertakings which are threatened by this bogey. Mr. Haldane's speech at the end of last week was welcomed in the Stock Exchange as evidence that the Government had not entirely sold itself into the hands of Labour, but prices recover with more difficulty than they decline, and Supply shares are weak.

To this reason is attributed the drooping of Metropolitan Electric Supply to 8, Westminsters to 9½, St. James to 10, City Lights to 10¼, and County of London to 8½. Edmundson's are ¼ easier at 3½, and an equal fraction came off London Electrics at 2, and Charing Cross at 4½. Chelseas are down to 5½. Nor have all the provincial shares been free. Oxfords fell to 6¼, although Folkestones regained the 2s. 6d. lost a week ago. The market has slipped into a languid condition even worse than that which prevailed prior to the little revival last July, and the loss of business adds a black frame to a picture already sufficiently depressing.

If Sir George Gibb hoped to pacify the Wimbledon travellers on the District Railway by his little compromise in the matter of fares, he must be feeling rather disappointed at the result of the reductions. The aggrieved areas are only the more encouraged to pursue their demands, and the agitators have not relaxed their efforts in the least. District stock keeps at 22, but Metropolitan advanced to 60½ upon the expectation of what effect complete electrification of the line may be likely to have upon traffics. A trial was run over the whole course one day last week. For the current half-year the takings have decreased to no less than £35,861. As one of its regular customers remarked, in describing the present conditions of travelling on the Metropolitan: "It is too unspeakable for words."

Central Londons, City and South and Waterloo and City stocks have not changed.

At one time, since we last wrote, British Electric Tractions were down to 4; as it is, the price is 4¼, while the Preference are about 8⅜. Both the Debenture stocks are lower. The movements are the more or less logical sequence to the doubtful wisdom of the company's financial policy in not making sufficiently liberal allowance in the past for reserve, depreciation and the like funds. With Tractions, Brush Ordinary have come down, the Ordinary losing 1/16 at 17s. 6d., and the Preference 5s. at 1½. London United Tramways Preference are a little harder at 9¼, work having just been commenced upon the company's new route from Wimbledon to Tooting.

Another sharp rise has lifted British Columbia Electric Railway Deferred to 127½, an advance of 4 points. Anglo-Argentine Ordinary are 1/16 harder, but Belgranos dropped ¼ to 3½.

In connection with the tramway market it is of melancholy interest to record the death of Mr. Thomas Ibbotson, a Stock Exchange member who, in conjunction with his partner, made tramway shares a speciality. Mr. Ibbotson was always courteous and patient in explaining even to the most obtuse, and his memory will live in the gratitude of many.

Movements in the Telegraph section are mainly downwards. The Anglo-American Telegraph trio has weakened in spite of the quarterly dividend of 15s. on the company's Ordinary stock. Direct United States are dull, despite the 4s. dividend just declared. An excellent report caused no movement in Cuba Submarines. Marconis fell to a sovereign, and Western Telegraphs lost half-a-crown. On the other hand, Reuters are again ⅛ better at 7⅞, and Commercial Cable bonds at 97½ are the fraction higher. The Indo-European dividend is at the rate of 5 per cent. Telephone issues are irregular. National Preferred is back to 110, and the Third Preference shares show 1/16 loss at 5⅝. Monte Video Ordinary are a shade firmer, the company raising its dividend from 4 to 5 per cent.

Manufacturing and Industrial shares have come under the bane of Labour, the weakness having little to counteract it in the shape of public support. Cromptons at 35s. have receded ⅛, and Westinghouse Preference at 25s. are ¼ down, the Debentures shedding 3 points to 77. The dividend and report made Edison & Swan better at first, but the partly-paid "A" shares are rather lower this week. Greenwood & Batley maintain their rise of the other day. Electric Construction Debenture fell a point. Willans & Robinson made further progress on the down grade, the Preference falling to 2¼, and at 34 Telegraph Construction shares are lower.

Bank Rate.—The Bank rate was yesterday raised to 5 per cent.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last four years. 1902.	1903.	1904.	1905.	Closing Quotations Oct. 2nd.	Closing Quotations Oct. 9th.	Business done week ended Oct. 9th, 1906. Highest	Lowest	Rise + or Fall —
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	3¾ – 4¼	3¾ – 4¼	..	..	..
155,600	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	5 %	84 – 93	88 – 93	..	..	..
702,600	Anglo-American Telegraph	Stock	60/6	61s.	2¾%	3½%	£6½ – £8½	66 – 68	£6⅞	..	— ½
3,148,700	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5¾%	6 %	113 – 114	112¼ – 113½	113½	112½	— ½
3,148,700	Do. do. do. Deferred	Stock	1/-	2s.	Nil	½%	24⅜ – 24⅝	24⅜ – 24⅝	24⅝	23⅝	— ⅛
50,000	Anglo-Portuguese Tel., 5% Mort. Deb. Stock Red.	100	..	..	..	..	101 – 103	101 – 103	..	..	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	8 %	8 %	6¾ – 7¼	6⅞ – 7¼	..	..	..
1,982,856	Commercial Cable Stlng. 500 year 4 % Deb. Sk. Red.	Stock	4 %	4 %	4 %	4 %	£6 – 98 xd	£6¼ – £8½ xd	97½	97	+ ½
16,000	Cuba Telegraph	10	6½%	10 %	5 %	5 %	8½ – 9	8½ – 9	8⅝	8 1/16	..
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	10 %	17 – 18	17 – 18	..	..	..
12,981	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	4 %	3⅝ – 3¾ xd	3⅝ – 3¾	..	..	..
6,000	Do. do. 10 % Cum. Pref. ..	5	10 %	10 %	10 %	10 %	8½ – 9¼ xd	8½ – 9¼	..	..	..
30,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	4½%	98 – 101	98 – 101	..	..	..
60,710	Direct United States Cable	20	3½%	3 %	3½%	4½%	15⅜ – 15½	15⅜ – 15½	15½	15 7/16	— ⅛
65,500	irect W. India Cable, 4½ % Reg. Deb., 1 to 1,200, R.	100	4½%	4½%	4½%	4½%	100 – 102	100 – 102	100½	..	..
4,000,000	Eastern & elegraph, Ord. Stock	Stock	7 %	7 %	7 %	7 %	144½ – 147½	144 – 147	146½	145	— ½
2,000,000	D o. 3½ % Pref. Stock	100	3½%	3½%	3½%	3½%	90½ – 92½	90½ – 92½	92½	91	..
1,848,772	Do. 4 % Mort. Deb. Stock Red. ..	Stock	4 %	4 %	4 %	4 %	107 – 109	107 – 109	108½	107½	..
800,000	Eastern Extension, Australasia, and China Tele.	10	7 %	7 %	7 %	7 %	14½ – 14¾	14½ – 14¾	14 1/16	14½	..
752,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	105½ – 107½	105½ – 107½	..	..	..
800,000	East & S. Afric. Tel., 4 % Mt. Db., 1 to 8,000, red. 1909	100	4 %	4 %	4 %	4 %	99 – 101	99 – 101	..	..	..
200,000	Do. 4 % Reg. M. Debs. (Mauritius S n b.) 1 to 8,000	25	4 %	4 %	4 %	4 %	101 – 103	101 – 103	..	..	..
180,887	Globe Telegraph and Trust	10	£3	5½%	5⅝%	5½%	10⅝ – 11⅛	10⅝ – 11⅛	11⅛	11	..
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	6 %	14⅝ – 14¾	14⅝ – 14¾	14¾	14⅜	..
150,000	Great Northern Telegraph, of Copenhagen ..	10	12½%	15 %	24 %	24%	£6 – 38	£6 – 38	37½	..	..
37,900	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,900, Red.	100	4½%	4½%	4½%	4½%	100 –102	100 –102	..	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	13 %	13 %	59 – 61	59 – 61	60½	59½	..
251,127	Marconi's Wireless Telegraph	1	Nil	Nil	Nil	Nil	1 – 1¼	⅞ – 1⅛	23/-	21/3	— ⅛
72,680	Monte Video Telephone Co., Ltd. Ord.	1	8 %	8 %	4 %	5 %	1⅛ – 1 1/16	1 – 1⅛	..	..	+ 1/16
86,492	Do. do. do. 5 % Pref. ..	1	5 %	5 %	5 %	5 %	⅞ – 1	⅞ – 1	..	..	..
1,983,333	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 %	109½ – 111½	109 – 111	110⅞	109½	— ½
1,966,667	Do. do. Def. Stock	100	4½%	5 %	5 %	5 %	109 – 111	109 – 111	110⅞	109⅝	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	6 %	11 – 13	11 – 13	12⅛	11 1/16	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 %	10⅛ – 12½	10⅛ – 12½	10⅝	..	..
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %	5 1/16 – 5⅛	5⅛ – 5⅛	5 1/16	..	— 1/16
2,000,000	Do. do. 3½ % Deb. Stock Red. ..	Stock	3½%	3½%	3½%	3½%	98 –100	98 – 100	99½	..	..
1,689,598	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	102 –104	102 –104	103½	..	..
179,313	Oriental Telep. and Elec. 1 to 171,504, fully paid	1	6 %	6½%	6½%	7½%	1 5/16 – 1 7/16	1 5/16 – 1 7/16	28/1½	27/-	..
50,000	Do. do. do. 6 % Cum. Pref. ..	1	6 %	6 %	6 %	6 %	1 5/16 – 1 7/16	1 5/16 – 1 7/16	..	..	— ⅛
100,000	Do. do. do. 4% Red. Deb. Stock	100	..	..	..	4 %	97 – 99	97 – 99	..	..	..
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	4 %	99 –102	99 –102	..	..	..
11,839	Reuter's	8	5 %	5 %	5 %	5 %	7⅞ – 7⅞	7⅞ – 8	7⅞	..	+ ⅛
60,000	Telephone Co. of Egypt, 4½ % Deb. Red.	100	..	..	..	4½%	101 –104	101 –104	..	..	..
3,201	Submarine Cables Trust	Cert.	6 %	6 %	6 %	6 %	129 –132	129 –132	..	..	..
70,000	United River Plate Telephone	5	7 %	8 %	8 %	8 %	7 – 7½	7 – 7½	..	..	..
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	5 %	5¼ – 5½	5¼ – 5½	..	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	5 %	109 –112	109 –112	..	..	..
15,609	West African Telegraph, Shares	10	2 %	4 %	4½%	4 %	9⅜ – 10⅛	9⅜ – 10⅛	..	..	..
30,098	W. Coast of America, 1 to 30,000 & 58,001 to 58,098	2½	Nil	Nil	Nil	Nil	⅜ – ½	⅜ – ½	..	..	..
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	4 %	100½ – 102½	100½ – 103½	..	..	..
207,930	Western Telegraph, Ltd., Nos. 1 to 207,930 ..	10	7 %	7 %	7 %	5 %	14⅜ – 14⅝	14½ – 14⅝	14⅝	14½	— ⅛
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	5 %	5 %	5 %	.. – ..	.. – ..	..	..	..
563,380	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	103 –106	103 –106	104	..	..
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	..	⅜ – ½	⅜ – ½	7/6	..	..
34,563	Do. do. 6 % Cum. 1st Pref.	10	7 %*	7 %*	6 %	5 %	6½ – 6¾	6½ – 6¾	..	..	..
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	Nil	4½ – 5½	4½ – 5½	..	..	..
80,000	Do. do. 5 % Debs., Nos. 1 to 1,800 ..	100	5 %	5 %	5 %	5 %	99 –102	99 –102	..	..	..

Including arrears.

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

170,000	Anglo-Argentine Trams, 260,008 to 430,007	5	..	..	5 %	8 %	7 – 7¼ xd	7 1/16 – 7 1/16 xd	7 3/16	7 1/16	..
100,000	Do. Nos. 430,008 to 910,007 and 560,008 to 580,007 ..	5	..	..	..	..	7 – 7¼	7 1/16 – 7 1/16	7 1/16	7 1/16	+ 1/16
260,007	Do. 5½ % Cum. Prefs., 1 to 260,007 ..	5	..	5 %	5 %	5½%	5 13/16 – 6 1/16	5 13/16 – 6 1/16	5 15/16	5 13/16	..
266,600	Do. Permanent, 6 % Deb. Stock, 1888	100	..	6 %	6 %	6 %	138 –141	139 –142	140½	..	+1
285,100	Auckland E. Trams., 5 % 1st Mort. Deb. Stock ..	100	..	5 %	5 %	5 %	103 –105	103 –105	..	..	..
800,000	Babcock & Wilcox, 1 to 530,000	1	..	17 %	20 %	20 %	3⅞ – 4⅛ xd	3⅞ – 4⅛ xd	80/-	77/6	..
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	..	6 %	6 %	6 %	1 7/16 – 1 15/16 xd	1 7/16 – 1 15/16 xd	..	..	..
88,000	British Aluminium, Ord., 2,001 to 40,000	5	..	..	7 %	7 %	5⅜ – 5⅝	5⅜ – 5⅝	..	..	..
40,000	Do. do. 7 % Cum. Pref...	5	Nil	Nil	7 %	7 %	6¼ – 6½	6¼ – 6½	..	..	..
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	6 %	6 %	5¼ – 5½	5¼ – 5½	..	..	..
20,000	Do. do. 4 % Funding Certs.	5	..	..	4 %	4 %	4 – 4⅛	4 – 4⅛	..	..	..
800,000	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	5 %	104 –108	104 –108	105	..	..
800,000	British Columbia E. Rail Def. Ord. Stock	100	..	6 %	6 %	6 %	122 –125	125 –130	127	124½	+3
300,000	Do. 5 % Pref. Ord. Stock	100	..	5 %	5 %	5 %	110 –113	110 –115	113½	111½	+1
115,000	Do. 5 % Cum. Perp. Pref. Stock	100	..	5 %	5 %	5 %	107 –110	108 –111	..	..	+1
240,400	Do. 4½ % 1st Mort. Debs., 1 to 6,250	40	..	4½%	4½%	4½%	104 –106	104 –106	..	..	..
220,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	..	4½%	4½%	4½%	102 –105	102 –105	..	..	..
133,801	British Electric Traction	10	8 %	6 %	6 %	3 %	4¼ – 5⅛	3⅞ – 4⅞	95/-	78/9	— ⅜
161,487	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	6 %§	8¾ – 9⅛	8 – 9	8 3/16	8¼	— ⅛
1,415,422	Do. do. 5 % Perp. Deb. Stock ..	Stock	5 %	5 %	5 %	5 %	109 –113 xd	107 –111 xd	110	108½	..
410,178	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	..	4½%	4½%	92½ – 95½	89 – 93	93	..	–2½
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	8 %	6¼ – 6½	6¼ – 6½	..	..	..
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %	5⅝ – 6⅛	5⅝ – 6⅛	..	..	..
600,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	4½%	102 –105	102 –105	..	..	..
212,000	British Thomson-Houston 4½ % 1st Mort. Debs. ..	100	..	4½%	4½%	4½%	94 – 98	94 – 98	..	..	..
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	..	6 %	Nil	..	1½ – 1⅝	1 – 1⅛	27/6	23/6	— ½
1,016,358	Do. do. 4 % Mort. Deb. Stock ..	100	..	4 %	4 %	4 %	77 – 83	77 – 80	78	..	–1
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	..	2/6 – 3/6	2/6 – 3/6	..	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731 ..	2	Nil	Nil	Nil	2½%	1 3/16 – 1 1/16	1 – 1	..	..	— 1/16
150,000	Do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	6 %	1 1/16 – 1⅛	1 1/16 – 1⅛	32/6	28/1½	— ½
125,000	Do. 4½ % Perp. Deb. Stock ..	Stock	4½%	4½%	4½%	4½%	96 – 98	96 – 98	..	..	..
125,000	Do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	82 – 84	82 – 84	..	..	..
100,000	Buenos Ayres & Belgrano, 1 to 100,000	5	..	3 %	4 %	3 %	3½ – 3⅝	3 – 3⅛	65/-	64/4½	— ⅛
40,000	Do. "A" 6 % Cum. Pref., 1 to 40,000	5	..	6 %	6 %	6 %	5⅛ – 5⅜ xd	5⅛ – 5⅜ xd	5⅜	..	..
27,500	Do "B" do. 1 to 27,500	5	..	6 %	6 %	6 %	4⅜ – 5⅜ xd	4⅜ – 5⅜ xd	..	..	..
317,700	Do. 5 % Deb. Stock	100	..	5 %	5 %	5 %	105 –107	105 –107	106	..	..
190,000	Do. 5 % 2nd Deb. Stock	100	..	5 %	5 %	5 %	102 –105	102 –105	..	..	..
105,000	Calcutta Trams., 1 to 105,000	5	..	6 %	8 %	8 %	8 – 8¼ xd	8 – 8¼ xd	8¼	..	..
32,610	Do. 105,001 to 137,610	5	..	..	..	8 %	7⅞ – 8⅛	7⅞ – 8⅛	..	..	..
350,000	Do. 4½ % 1st Deb. Stock	100	..	4½%	4½%	4½%	103 –106	103 –106	105	103½	..
35,000	Callender's Cable Construction shares	5	15 %	12½%	12½%	15%	10¾ – 11⅛	10⅜ – 11⅛	..	..	..
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅝ – 5¾	5⅝ – 5¾	5⅞	5⅝	..
300,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	108 –110	108 –110	..	..	..
491,222	Cape E. Trams., 1 to 491,222	1	..	15 %	10 %	5 %§	⅜ – ⅝	⅜ – ⅝	12/9	..	..
450,000	Castner-Kellner Alkali, 1 to 450,000	1	..	4 %	4 %	6 %	1 3/16 – 1 5/16	1 3/16 – 1 5/16	21/3	..	..
230,211	Do. do. 4½ % 1st Mort. Deb. Stock	100	..	4½%	4½%	4½%	97 –102	97 –102	..	..	..
1,939,698	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	4 %	83 – 85	83 – 85	84	83½	..
530,316	Do. do. 4 % Pref. Stock ..	Stock	4 %	4 %	4 %	4 %	97 – 99	97 – 99	99	98	..
530,316	Do. do. Def. do.	Stock	4 %	4 %	4 %	4 %	73 – 76	73 – 76	73⅝	..	..
1,480,000	City and South London Railway	Stock	3½%	2⅝%	2½%	1¾%	42 – 44	42 – 44	44	43	..
85,000	Crompton & Co., Nos. 1 to 85,000	8	5 %	2½%	2½%	2½%	1⅜ – 1⅝	1½ – 1⅝	30/7½	..	— ⅛
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	..	5 %	5 %	5 %	5 %	95 – 98	95 – 98	..	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § Interim dividends.
¶ And bonus of 10s. ¶ From Manchester Share List.

(Continued on next page.)

SHARE LIST OF ELECTRICAL COMPANIES.—*(Continued)*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—*(continued).*

Present Issue.	NAME,	Stock or Share.	Dividends for the last four years. 1902.	1903.	1904.	1905.	Closing Quotations Oct. 2nd.	Closing Quotations Oct. 9th.	Business done week ended Oct. 9th, 1906. Highest.	Lowest.	Rise + or Fall—
260,000	Dick, Kerr & Co., 1 to 260,000	1	..	..	10 %	..	1⅜ — 1⅞	1⅜ — 1⅞	35/3	24/3	..
805,000	Do. do. 6 % Cum. Pref., 1 to 805,000	1	..	6 %	6 %	6 %	1 1/16 — 1 1/8	1 1/16 — 1 1/8 xd	..	..	..
294,150	Do. do. 4½ % Deb. Stock	100	..	4½ %	4½ %	4½ %	103 —106	103 —106	..	..	..
60,000	Dublin United Trams. (1896), 1 to 60,000	10	..	5½ %	6 %	6 %	14 — 15	14 — 15	..	..	..
59,987	Do. 6% Pref. between 1 and 60,000	10	..	6 %	6 %	6 %	14 — 15	14 — 15	..	..	..
99,261	Edison & Swan Utd., "A" shrs., £8 pd., 1 to 99,261	5	Nil	Nil	2 4/5 %	4 1/5 %	1⅞ — 2	1⅞ — 1⅞	36/10½	34/4½	— ⅛
17,189	Do. "A" shares, 01—017,189	5	Nil	Nil	2 4/5 %	4 1/5 %	2⅝ — 3	2⅝ — 3	57/6	..	..
844,023‡	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	86 — 87	86 — 88	..	..	+1
100,000‡	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	5 %	89 — 94 xd	90 — 95 xd	..	..	+1
112,100	Electric Construction 1 to 112,100	2	6 %	4 %	Nil	Nil	⅛ — ¼	⅛ — ¼	..	..	..
81,890	Do. do. 7 % Cum. Pref., 1 to 81,890	2	7 %	7 %	7 %	7 %	1¾ — 2	1¾ — 2¼	..	..	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Stk.	Stock	4 %	4 %	4 %	4 %	85 — 88	84 — 87	..	..	—1
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	5 %	9 — 9½	9 — 9½	..	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	4 %	91 — 94 xd	91 — 94	..	..	..
78,000	Gt. N. & City Rail Pref. Ord. "A" 4 % 1 to 78,000	10	..	3 %	4 %	4 %	3¾ — 4	3¾ — 4	75/-	71/3	..
96,000	Greenwood & Batley 7 % Cum. Pref.	10	..	7 %	7 %	7 %	10¼ — 10¾	10¼ — 10¾	..	..	..
80,000	Do. do. 5 % Mort. Debs.	100	..	5 %	5 %	5 %	101 —102	101 —102	..	..	..
200,000	Henley's (W. T.), Telegraph Works, Ord.	5	20 %	15 %	15 %	15%	12 — 13	12 — 13	..	..	..
900,000	Do. do. 4½ % Pref.	5	4½ %	4½ %	4½ %	4½ %	5¼ — 5½	5¼ — 5⅝	..	..	..
150,000	Do. do. 4½ % Mort. Deb. Stock	Stock	4½ %	4½ %	4½ %	4½ %	107⅓ —109⅔	107⅓ —109⅔	107½	..	..
60,000	India-Rubber, Gutta-Percha & Telegraph Works.	10	10 %	10%	5 %	10%	17 — 18	17 — 18	..	..	..
87,500	†Liverpool Overhead Railway, Ord.	10	1⅛%	1⅛%	1⅛%	Nil	1 1/16 — 1 1/8	1 1/16 — 1 1/8	..	..	..
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	5 %	4¼ — 6¼	4¼ — 6¼	..	..	..
600,070	London United Trams (1901), 1 to 50,007	10	..	8 %	6 %	3 %	8 — 8½	8 — 8½	..	..	..
899,930	Do. do. 60,008 to 100,000 (£6 paid)	10	..	8 %	6 %	3 %	3½ — 4	3½ — 4	..	..	..
125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	..	5 %	5 %	5 %	8¾ — 9¼	9 — 9½	9⅜	9¼	..
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	93 — 96	93 — 96	96	..	..
814,016	Metropolitan Electric Trams, Defd.	1	Nil	Nil	Nil	3 %	⅛ — ⅜	⅛ — ⅜	..	..	..
500,000	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	1 1/16 — 1 1/8	1 1/16 — 1 1/8	..	..	..
950,000	Do. 4½ % Deb. Stock Red.	100	..	..	4½ %	4½ %	98½—100½	98 —100	..	..	— ½
150,000	Peebles (B.) & Co. 6 % Cum. Pref., 20,001 to 50,000	5	..	..	6 %	6 %	4¾ — 5	4¾ — 5 xd	..	..	..
24,500	Potteries E. Trc., 20,001 to 40,000 & 50,001 to 54,500	10	..	5 %	5 %	4 %	6¾ — 7¼	6¾ — 7¼	..	..	..
24,500	Do. 5 % Cum. Pref., 1 to 20,000 & 40,001 to 44,500	10	..	5 %	5 %	5 %	7¾ — 8¼	7¾ — 8¼	..	..	..
245,000	Do. 4½ % Deb. Stock	100	..	4½ %	4½ %	4½ %	100 —103	100 —103	..	..	..
87,850	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	15 %	33½ — 35½	33 — 35	33⅝	33⅓	— ½
150,000‡	Do. 4 % Deb. Bds., 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..
8,599,200	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	..	..	5 %	5 %	90 — 92	90 — 92	..	..	..
540,000	Waterloo & City Railway, Ord. Stock	100	3½%	3½%	3½%	3½%	101 —104	101 —104	102	101	..
66,666	Willans & Robinson, 1 to 30,000 & 80,001 to 116,666	5	8⅓%	3 %	Nil	Nil	⅛ — 1	⅛ — 1	..	..	..
66,666	Do. 6 % C. P., 30,001 to 80,000 & 125,001 to 141,666	5	..	6 %	Nil	Nil	2⅜ — 3	1⅞ — 2¼	37/6	..	— ¾
246,806	Do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	77 — 82	75 — 80	75	72	—2

ELECTRICITY SUPPLY COMPANIES.

14,000	Bromley (Kent) E.L. & P., 1 to 14,000	5	..	5 %	5⅛%	4 ⅝%	5 — 5⅛ xd	5 — 5⅛ xd	..	..	..
50,000	Do. do. 4½ % 1st. deb. stock	100	..	4½ %	4½ %	4½ %	101 —104	101 —104	..	..	..
29,377	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	5	8 %	10 %	10 %	10 %	8¼ — 8¾	8¼ — 8¾	..	..	..
10,623	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	7 %	7⅞ — 8	7⅞ — 8	..	..	..
300,000	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	4 %	101 —104	101 —104	102⅝	101½	..
80,000	Charing Cross and Strand Electricity Supply	5	10 %	8 %	8 %	5 %	4⅜ — 4⅞	4¼ — 4¾	80/-	..	— ¼
80,000	Do. do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	4½%	4¾ — 5	4¾ — 5	96/3	..	..
80,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½%	4½%	4½%	4½%	4 — 4½	4 — 4½	..	..	..
420,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	101 —104	101 —104	..	..	..
44,436	Chelsea Electricity Supply, Ord.	5	4½%	5½%	6 %	6 %	5⅜ — 5⅞	5¼ — 5⅜	..	..	— ⅛
175,000‡	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	106 —109	106 —109	..	..	..
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	5 %	5 %	6 %	6 %	10 — 10	9¾ — 10⅜	10 7/16	..	— ⅛
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	6 %	11⅛ — 12⅛	11⅛ — 12⅛	..	..	..
400,000‡	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	5 %	123 —126	123 —126	125	124⅜	..
300,000	Do. 4½ % 2nd Db. Stk., Prov. Crts., all pd.	100	4½%	4½%	4½%	4½%	100 —103	100 —103	101	..	..
40,000	County of Durham Electrical Power, Ord.	2	4 %	4 %	£3 7 0	4 %	2⅛ — 3⅜	2⅛ — 3⅜	63/3	..	..
50,000	Do. do. do. 5 % Pref.	5	5 %	5 %	5 %	5 %	5 — 5⅛	5 — 5⅛	..	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½%	5 %	8½ — 9	8¼ — 8⅝	8⅝	8⅜	— ¼
80,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	6 %	11⅝ — 12	11⅝ — 12	..	..	..
400,000‡	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	4½%	107 —110	107 —110	..	..	..
400,000	Do. do. 4½ % 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	101 —104	101 —104	101½	..	..
80,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	4 %	3⅜ — 3⅞	3¼ — 3⅜	..	..	— ⅛
80,000	Do. do. 6 % Cum. Pref.	..	6 %	6 %	6 %	6 %	4¼ — 5⅛	4¼ — 5⅛	5 1/16	5 1/16	..
320,000	Do. do. 4½ % 1st Mort Deb. Stk	100	4½%	4½%	4½%	4½%	100 —103	100 —103	..	..	..
10,000	Folkestone, 1 to 10,000	5	..	5½%	5½%	5½%	5 — 5½ xd	5⅛ — 5⅜ xd	..	..	..
10,000	Do. 5 % Cum. Pref., 1 to 10,000	5	..	..	..	5 %	4⅞ — 5⅛ xd	4⅞ — 5⅛ xd	..	..	..
75,000	Do. 4½ % 1st. Deb. Stock	100	..	4½%	4½%	4½%	99 —102	99 —102	..	..	..
13,000	Hove, 1 to 13,000	5	..	8½%	8½%	9 %	8¼ — 8⅝	8¼ — 8⅝	..	..	..
10,000	Do. New (£6 10s. paid)	£3	..	8½%	8½%	9 %	6½ — 6⅞	6½ — 7¼	..	..	+ ⅛
87,303	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	99 —101	98 —100	..	..	—1
7,300	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	99 —101	98 —100	..	..	—1
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	12½	12 %	10 %	9⅜ — 10⅜	9⅜ — 10⅜	..	..	..
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	4 %	99 —102	99 —102	100⅜	100	..
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	Nil	3 %	4 %	1⅞ — 2⅛	1⅞ — 2⅛	..	..	— ⅛
60,000	Do. do. do. 6 % Pref.	5	6 %	6 %	6 %	6 %	5 — 5⅛	5 — 5⅛	..	..	..
874,395	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	96 — 99	96 — 99	..	..	..
200,000	Metropolitan Electric Supply, 1 to 100,000	5	7½%	8½%	10 %	10 %	8 — 8½	7⅞ — 8⅛	8⅛	7 13/16	— ⅛
76,121	Do. 4½ % Cum. Pref. 1—71,106, £3 pd.	5	4½%	4½%	4½%	4½%	5⅛ — 5⅜	5⅛ — 5⅜	5 3/16	..	..
220,000‡	Do. 4½ % 1st Mort. Deben. Stock	..	4½%	4½%	4½%	4½%	109 —113	109 —113	..	..	..
260,000‡	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½%	3½%	3½%	3½%	95 — 97	95 — 97	..	..	..
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	4½%	98 —101	98 —101	100	..	..
75,000	Newcastle-on-Tyne, 1 to 75,000	5	..	8 %	8 %	8 %	7⅞ — 8	7⅞ — 8	..	..	..
75,000	Do. 5 % Pref., 1 to 75,000	5	..	5%	5 %	5 %	5⅜ — 6⅛	5⅜ — 6⅛	..	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	7½%	13½ — 14½	13½ — 14⅝	..	..	..
64,000	Do. do. 4 % 1st Mort. Deb.	100	4 %	4 %	4 %	4 %	96 — 98 xd	96 — 98 xd	..	..	..
18,500	Oxford, 1 to 96 and 407 to 18,810	5	..	6½%	7 %	7 %	6½ — 6⅝	6 — 6½	..	..	— ⅛
50,000	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	98 —100	98 —100	..	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	12½%	9¾ — 10⅜	9½ — 10½	10	..	— ¼
20,000	Do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	7 %	7 — 8	7 — 8	..	..	..
150,000‡	Do. do. 3½ % Deb. Stock Red.	100	3½%	3½%	3½%	3½%	95 — 97	95 — 97	..	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	2½%	4 %	4 %	4 %	1 — 2	1 — 2	..	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	74 — 78	74 — 78	..	..	..
65,000	South London Electricity Supply, Ord.	5	12½%	8 %	4 %	4 %	2⅜ — 3½	2⅜ — 3½	..	..	..
103,700	South Met. Elec. Lt. & Power (Ord.	1	Nil	Nil	Nil	2½%	⅛ — ⅜	⅛ — ⅜	..	..	..
85,868	*(Late Blackheath and Greenwich* 7 % Pref.	1	Nil	7 %	7 %	7 %	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..
148,292	*Dist. E.L.Co.)* 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	4½%	102 —105 xd	102 —105 xd	..	..	..
50,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	5 %	3½ — 3⅝ xd	3⅜ — 3⅝ xd	..	..	..
80,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	4½ — 4⅝ xd	4½ — 4⅝ xd	..	..	..
00,000	Do. do. 4½ % 1st Mort. Db. Stk. Red	100	..	..	4½%	4½%	97 —100 xd	97 —100 xd	99	97½	..
110,000	Westminster Electric Supply, Ord.	5	12 %	13½%	14 %	13 %	9⅜ — 10⅛	9 — 10	9⅛	..	— ⅛
23,151	Do do. 4½ % Cum. Pref.	5	5 %	5 %	5 %	5 %	5½ — 5⅝	5½ — 5⅝	5 5/8	5⅝	..
	(Originally 5 %—Red. to 4½ % from 31st Dec., 1905.										

Shares not officially quoted:—Mackay Companies, ord., 75—77. Pref. 74—76.

† Unless otherwise stated all shares are fully paid. ‡ Interim dividends.

(Bank rate of discount 4 per cent. September 13th, 1906).

NOTES ON THE WORKING OF WATER-TUBE BOILERS.

By R. SOMERVILLE BAYNTUN, A.M.I.C.E., A.M.I.M.E., A.M.I.E.E.

The following notes are based on experience gained by the author during the past few years with various types of water-tube boilers. The tests described have proved of much value for keeping the boilers under treatment in good condition and for minimising priming. In one case where an installation of boilers had been burning out tubes at an average rate of 20 per month for some years, these tests were carried out, and by their assistance the failures of tubes were immediately stopped, not a single tube having failed for 18 months.

While it is indisputably of great assistance to have a trained chemist to supervise such tests, yet few electrical power stations are able to have one, and the tests hereafter described may be made by an unskilled man. In the author's station they are made by improvers, the results being occasionally checked. The solutions should all be obtained ready made up from chemists who are used to making up analysts' reagents, and not too much should be obtained at once, as they should be used fairly fresh.

The one great point requiring attention is to use the utmost cleanliness in all the tests. Separate burettes should be used for each solution, and should never be interchanged. All vessels should be well washed after use, and given a final rinse with distilled water.

It is not claimed that all these tests are chemically accurate, as in some cases there are foreign substances present in the water under test which may impair the accuracy. However, they are all that is required for practical purposes to determine whether the conditions of steaming are good.

They are primarily intended for plants having water-tube boilers where surface condensers are used, the air pump discharge being filtered by a chemical filter using alumina sulphate and soda ash as the reagents. The air pump discharge test is only suitable where the circulating water is saline.

Boiler Water Tests.—A sample is drawn from one or two boilers each day, so that each boiler may be tested once a week. It is most conveniently taken from the gauge glass drain after about three minutes' blowing through. Careful tests have shown that there is no difference in density between a sample thus obtained and one taken from the blow-down. Any considerable amount of suspended matter would probably show that the filter had been passing precipitate. In small quantities this does no harm, but if much be present priming is likely to occur. The sample is tested for alkalinity and salt as indicated below.

Air Pump Discharge.—This is tested for salt to detect leakage of condenser tubes or ferrules. The test, which is only possible when the circulating water is salt, is a very delicate one, it being possible to detect a pin-hole in one tube out of 3,000 by this means.

With water-tube boilers of small steam disengaging surface it is a most important point to detect such leakage, as these boilers will often prime dangerously with less than 4 per cent. of the salt that might be allowed to exist in a marine type boiler.

In cases where the circulating water is fresh water, the condenser may be tested by shutting it off with the vacuum in it, allowing it to stand for some time, drawing off a sample of water from the steam space, and testing it for hardness as below. If the hardness is above one degree there is leakage.

Filter Discharge.—This should be tested every day for alkalinity. The sample should be the average of a dozen or so taken at five minutes' intervals, or may be drawn by means of a small siphon or tap into a bucket. The precise degree of alkalinity required depends chiefly on the hardness and quantity of the make-up water. Where this contains any sulphates of lime and magnesia, it is advisable to maintain such an excess of sodium carbonate in the filter discharge as shall reduce these sulphates to carbonates, thus avoiding the deposition of hard scale in the boiler. A slight excess of sodium carbonate is therefore maintained in the boiler to ensure this being done; 10 to 20 grains per gallon will be ample, and will not give rise to any priming.

Make-up Water.—This should be periodically tested for hardness, as even a town's supply will often vary considerably at different seasons and in various weathers, and will thus require a varying excess of sodium carbonate in the filter discharge.

Alkalinity Tests.—The apparatus required for these tests comprises: Two 25-cc. burettes, one double burette stand, one 100-cc. measuring cylinder, one beaker of about 200 cc. capacity, and a spirit lamp with tripod.

Standard decinormal sulphuric acid and sodium hydrate solutions and litmus solution will also be needed. These solutions should be obtained ready made up and standardised by a manufacturing chemist.

The procedure is as follows: Measure 74 cc. of the test sample and put it in the beaker, adding a few drops of litmus solution to colour. Put a convenient quantity (say 20 cc.) of the acid solution into one burette, and add by small quantities to the sample in the beaker till this turns red, adding about 2 cc. excess to ensure distinct acidity. Note carefully the exact amount used. Then boil the sample over a spirit lamp for 10-15 minutes to drive off the carbon dioxide generated by the previous titration. Next put some sodium hydrate solution into the other burette and titrate the solution back to neutrality (which is shown by the purple colour), noting carefully the quantity required. Then the excess of acid used over the sodium hydrate multiplied by 5 will give the alkalinity in grains of sodium carbonate per gallon. Example:—

Water taken, 74 cc.; acid to turn solution red, 1·5 cc.; two cc. of acid added, makes total 3·5 cc.; sodium hydrate added after boiling, to bring solution back neutral, 1·25 cc.

Then $3{\cdot}5 - 1{\cdot}25 = 2{\cdot}25$,

$2{\cdot}25 \times 5 = 11{\cdot}25$ grains per gallon.

Limit.—The filter discharge should not get above 2 or 3 grains per gallon, nor the boiler above 20 grains per gallon.

Instead of the above test a similar one may be made using methyl orange as the indicator instead of litmus, and in this case it is only necessary to titrate to neutrality with the acid solution, and then calculate the final result as before. The disadvantage of this method is that the methyl orange is not nearly as sensitive as litmus, and the precise moment of change of colour is difficult to determine, so that a considerable error is often introduced.

Salt Tests.—The apparatus needed for this test is:—One 25-cc. burette and stand, one 200-cc. beaker and one 100-cc. measuring cylinder. Standard decinormal silver nitrate solution and potassium chromate solution for use as the indicator will also be required.

The same test may be used for both air pump discharge and boiler water, but in the latter case it is advisable to take a smaller quantity as a sample, to avoid using a large quantity of the silver nitrate solution. Therefore, 75 cc. is a convenient quantity to take for the air pump discharge test and 25 cc. for the boiler water test. Measure the required quantity of water in the cylinder, pour it into the beaker with a few drops of the potassium chromate solution, and titrate with the silver nitrate solution, adding drop by drop from the burette. If any salt be present, a white precipitate of silver chloride will be formed, giving the water a milky appearance. Add the silver nitrate till a red precipitate is formed, which does not quite disappear on shaking, *i.e.*, which gives a faint reddish tinge to the solution. This indicates that all the salt has been taken up by the silver nitrate, and that silver chromate is being precipitated. The volume added should be carefully noted and multiplied by 16 in the case of 25 cc. being taken, or by 5·4 if 75 cc. are taken. This gives the grains of salt per gallon present in the sample.

Limit.—The amount of salt which may be allowed in a water-tube boiler depends chiefly on the liability to priming which exists. With boilers whose steam-disengaging water surface is small, it is not advisable to get above 200 grains per gallon.

The air pump discharge should not get above 3 or 4 grains per gallon, as it soon concentrates in the boilers.

Hardness Test.—For this test, a 25 cc. burette and stand will be required, also a wide-necked stoppered bottle, and some Clarke's standard soap solution. Take 50 cc. of the sample and pour into the bottle, add the soap solution by

quantities of ½ cc. at a time, closing the bottle and shaking well after each addition.

It is necessary to obtain a lather that will remain for two minutes when the bottle is laid on its side. When this point is reached, the quantity of soap solution used is noted, and the result obtained by referring to a table, a copy of which is given below, in which the degrees of hardness are expressed as parts per 100,000 :—

cc. soap used.	Degrees of hardness.	Soap.	Hardness	Soap.	Hardness	Soap.	Hardness.
1	·48	5	6·0	9	11·8	13	18·02
1·5	1·27	5·5	6 71	9·5	12·56	13·5	18 81
2	1·97	6	7·43	10	13·31	14	19·6
2·5	2·6	6·5	8·14	10·5	14·06	14·5	20·4
3	3·25	7	8 86	11	14·84	15	21·19
3·5	3·9	7·5	9·57	11·5	15·63	15·5	22·02
4	4·57	8	10·3	12	16·43	16	22·86
4·5	5·29	8 5	11·05	12·5	17·22	—	—

If the water is so hard that 50 cc. requires more than 16 cc. of soap solution to form a permanent lather, take half the quantity, make up to 50 cc. with distilled water that has been recently boiled for 10 minutes (to drive off the carbon dioxide), proceed as before, and double the figures given by the table.

SOME RECENT ELECTRICAL CASES.

[BY OUR LEGAL CONTRIBUTOR.]

At the close of the legal year, it is often well to pass in review some of the cases which have been considered by the Courts in relation to any particular trade or industry. Though they do not often figure in the High Court, electrical undertakers are sometimes forced to go there in spite of themselves. Although knowledge of electric lighting law may not often be wanted, still, when it is wanted, it is wanted—as the American said of the revolver—"mighty badly."

Questions relating to the transfer of electrical undertakings from local authority to company, and *vice versâ*, are not of frequent occurrence, but are likely to be of considerable importance within the next few years. It is anticipated that where local authorities have been unable to make their undertakings profitable, they will be glad to seize any opportunity of transferring their powers to a company ; while the time is rapidly approaching when the power of compulsory purchase by a local authority may be exercised. Agreements for the transfer of electrical undertakings must be sanctioned by the Board of Trade, and the question has recently arisen as to what agreement must be sanctioned.

It appears from the recent case of Mayor of Lambeth *v.* South London Electric Supply Corporation, that all the terms of the arrangement must be brought before the Board. By a provisional order, confirmed by statute, a local authority were made the undertakers for the supply of electrical energy for lighting purposes within their district, and they were enabled, with the approval of the Board of Trade, to transfer their powers. The local authority entered into negotiations with a company for the transfer to the latter of their powers, and it was agreed that the company, as a term of the transfer, should erect and maintain a dust destructor and dispose of the refuse supplied to them by the local authority. A deed containing these terms was submitted to the Board of Trade, but the Board refused to approve of it upon the ground that they had nothing to do with the erection of a dust destructor. Two deeds were then drawn up, the first for the transfer of the powers of the local authority as to electric lighting, which the Board of Trade approved, and the second for the erection and maintenance by the company of a dust destructor. The destructor having been erected, the company refused to maintain it and to dispose of the refuse. In an action by the local authority for a declaration of their rights, it was held that, as the execution of the second deed relating to the dust destructor was a term of the first deed, it required the approval of the Board of Trade, and without that approval it was invalid.

The question of compulsory purchase has also arisen in relation to electric tramways. Just as, under the Electric Lighting Acts, the undertaking of a company may be brought up by the local authority at some time or other on the terms of the local authority paying the "then value" of the undertaking, so, under Sec. 43 of the Tramways Act, 1870, a tramway company may have to transfer their property and goodwill. The question—What constitutes the "then value" has given rise to some difficulty in practice. It would seem to mean the value to the sellers not the value to the buyers. It was decided by the House of Lords in the recent case of Manchester Carriage and Tramway Co. *v.* Swinton and Pendlebury U.D.C. (22 T.L.R. 154) that where a local authority purchase the undertaking of a tramway company under Sec. 43 of the Tramways Act, 1870, they may be compelled to purchase a depôt outside their district which is suitable to and used by the tramway company for the purposes of their undertaking within the district. "The then value" of the tramway, &c., in Sec. 43, means the value to the promoters, and not the value to the purchasing authority, at the date of the notice requiring the tramway company to sell. The decision of the Court of Appeal was reversed, and the judgment of Justice Channell restored, upon the ground that the finding of the arbitrator in the special case was not ambiguous, and that he had found that the depôt was suitable to and used for the purposes of the undertaking. The effect of this decision may be illustrated by considering the position of an electric lighting company selling their undertaking to a local authority who desired to "scrap" the old plant, and substitute new therefor. In such a case the "then value" would not be the value of old iron but the value which the plant was to the vendors.

While local authorities in their position as undertakers for the supply of electricity have many privileges, they are by no means all-powerful ; and are not permitted to exceed the rights and privileges conferred upon them by statute. So, where land is purchased by agreement for the purpose of erecting a generating station, the building of a refuse destructor thereon will be prohibited by the Court. (In Attorney-General *v.* Pontypridd U.D.C. (22 T.L.R. 576.))

A local authority, who were the undertakers for the supply of electricity within their district, purchased, by agreement, land for the erection thereon of an electric generating station. The whole of the land not being wanted for the generating station, they proceeded to erect a refuse destructor on part of the land, intending to utilise the heat derived from the refuse destructor in the generation of electrical energy. At the time they purchased the land they intended so to use it, but this was not communicated to the vendor. It was held that the local authority were not entitled to use the land, which was acquired for the purpose of erecting a generating station, for the erection of a refuse destructor, which was no part of the generating station, and was neither necessary nor incidental to the supply of electricity, and that an injunction would be granted to restrain them from doing so.

Where electric tramway undertakers have the right to run trams through city streets, they also have certain obligations imposed upon them. Thus the highway authority are generally relieved from the duty of maintaining or repairing that part of the road which is occupied by the track, this work being handed over entirely to the tramway company. Where disputes arise as to the construction of the clause which imposes this obligation, they are in general referred to arbitration, and it has recently been decided under a local Act that disputes relating to the question as to who is to repair the junction between tramway track and road metal must also be referred. Competition is so keen between tramways and 'buses that the owners of these vehicles are glad to make what profit they can out of advertisements. As a general rule, so much is paid each year for the privilege of placing advertisements on "each running car." The meaning of the term "running car" has recently come before the Courts for consideration. In Griffiths *v.* Mayor of Southampton (22 T.L.R., 301) the corporation of a borough, which owned the tramways therein, agreed to permit the plaintiffs for five years to affix advertisements

upon all the electric tramcars, and the plaintiffs were to pay to the corporation certain annual rents "for each and every regular running electric tramcar," the rents to be payable quarterly in advance. There was also a provision that the plaintiffs should remove the advertisements from any car which had to be repainted and replace them at their own expense without any compensation. It was held that a regular running car meant a car which was in the service of the undertaking as part of the rolling stock intended for regular use at the beginning of the year, having regard to the nature of the route and the exigencies of the traffic, and that car was not less a regular running car by reason of occasional withdrawals for repainting and repairs.

The question of nuisance caused by electrical undertakers has also been considered within the last few months. Some of the residents in a street adjoining the King's Road electricity works of the St. Pancras Borough Council brought an action to restrain the Council from continuing a nuisance caused by their dust destructor and electricity works; and, while the residents lost their case so far as the dust destructor was concerned, they succeeded in obtaining an injunction restraining the defendants from working their engines so as to cause vibration sufficient to constitute a "legal nuisance."

The trouble in question was caused by a three-crank compound steam engine, driving a 450-KW. continuous-current dynamo, which had been the cause of complaint in a former action. Since then, however, the balancing of the engine had been improved by carrying out certain recommendations of Prof. Dalby, but recently the set had needed repair, and, after it had been taken down and re-erected, the vibration was once more evident. It was practically admitted by the defendants that there had been a certain amount of vibration when this particular engine was running. The serious matter for consideration is the effect of such decisions in hampering the development of the electricity supply industry, which is already crippled by a number of legal restrictions. The following clause is included in every Electric Lighting Order: "Nothing in this order shall exonerate the undertakers from any indictment, action or other proceedings for nuisance in the event of any nuisance being caused by them." Thus, although the electricity supply undertaker is bound, under penalty, to supply electricity to practically every consumer who requires it, and must, therefore, gradually increase the size of his works, and put in larger generating units, yet he is liable to an injunction at any time calling upon him to stop these engines if it can be proved that they cause sufficient vibration to be objectionable to those living near the works. For if a 450-KW. set, even though it be a badly balanced reciprocating engine, creates an "actionable nuisance," the sets of twice, thrice or 10 times the size, now being installed in electricity works, may well do the same, for presumably noise is a nuisance just as much as slower vibrations; and the large turbine sets that are now built do not always run silently. A simple remedy for this state of affairs would be, of course, for the electricity supply authorities to buy the property surrounding the works; but, unfortunately, the undertaker has no power of compulsory purchase under the Electric Lighting Acts. As a matter of fact, the St. Pancras Borough Council in the case just alluded to, had already acquired the land on which the houses stood, but not the leases, and one result of the action was that the Council finally bought the leases at a far higher price than they would otherwise have had to pay. It may be mentioned, with reference to this case, that the St. Pancras Borough Council have recently introduced a Bill into Parliament with a view to relieving themselves of this clause.

Battery Maintenance.—The HART ACCUMULATOR CO. have been maintaining the battery in connection with the electric lighting at the Deptford Baths and the Town Hall for £14 17s. per annum. Their agreement expires on October 27th, and they require the payment to be increased to £28 per annum, as the market price for raw material has increased cent. per cent. since the battery was first put in. Under these circumstances the Baths Committee has resolved not to renew the agreement with the company, but to place the maintenance of the battery in the hands of the Baths engineer and his staff.

OUR UNIVERSITY LABORATORIES: A DEFENCE.

[COMMUNICATED.]

TIRED of the silly season sea-serpent and wearied of the confusing facts and figures of the fiscal alarmists, certain daily newspapers have recently been enlivening their readers with periodic incursions into the realms of engineering science. To some extent one feels a certain amount of sympathy with the benign proprietors of newspapers who wish to educate the man in the street in matters scientific. There is obviously very great need to educate, in things appertaining to machinery, that much-talked of individual for whom the daily newspaper serves up the tragedies and the humours of life. Nowadays we are all motorists, for a penny 'bus fare entitles us to speak upon small details such as carburettors, ignition or compression with the authority of a specialist. It is true that our friend the passenger in the motor-'bus is not so happy when he wanders like a veritable Mrs. Malaprop into technical terms concerning electricity. Yet it must be confessed, and it is pleasing to notice it, that even the average product of free education takes an interest in the all-pervading motive and lighting power of the twentieth century. As Sir Norman Lockyer has said, "we are in a world which has been entirely changed by the advent of modern science, modern nations, and modern industries," and perhaps it is well to have science, diluted with catchy phrases, served up to the multitude, always assuming that the facts of the case are not misstated.

A few days ago there suddenly appeared an engineering section in the great champion of the fiscal propaganda, and the authorised organ of the tariff commission. After an informing introductory notice, with which we are somewhat in sympathy, there was a sort of leaderette under the heading "Are our University Laboratories Obsolete?" We learn that "our mind" gained a very unfavourable impression after "visits to the engineering laboratories of some of our leading teaching institutions." There is a good deal which might be contested in this leaderette, but the sentence which especially demands interrogation is the following: "The laboratories are for the most part equipped with toy machinery of an obsolete kind, which has the effect of giving the students a false idea of proportion." It may be that there were many anxious parents undecided how to start their sons in their careers as engineering learners, who read that sentence, and who promptly decided to give their sons the greatest handicap possible to a would-be engineer, an entirely workshop education. That is where the daily papers have such a great responsibility, for they reach alike the wise and the ignorant. "Toy machinery" is apt to remind us of the historic tea kettle of James Watt, the kite of Franklin, the apple of Newton, or even the first small 10-H.P. turbine of Parsons. The writer of those words rushes into the usual fallacy that only with huge apparatus can proper laboratory instruction be given. Mention is made by him of the wonders of American University laboratories; and while we on this side of the Herring Pond are possibly envious of the huge sums of money with which these places are endowed, yet we can at least claim that, dollar for dollar expended, our own colleges turn out better results. The all-important subject of research is calmly ignored by our friend of the lay Press; but let us for a moment see where the great discoveries and inventions have sprung from. We start off with a tribute to America's Benjamin Franklin, and then pass on to the roll of England's workers in the same science. Faraday, the discoverer of electrical induction, from which the dynamo and practically all the vast electrical industries have sprung, worked in London. Daniel, the inventor of the electric battery; Wheatstone, rendered immortal by the telegraph; Clerk-Maxwell and the late Dr. John Hopkinson all worked in an "obsolete laboratory" in the Strand. It is a curious fact that nearly all of the inventors and masters of research have come from these belittled English laboratories. We have still with us, and working for the progress of science, such men as Kelvin, Crookes, Lodge and J. J. Thomson.

The Object of the Laboratory.

What seems to be in danger of being lost sight of in any discussions upon laboratory instruction is the fact that the main purpose of any experimental work conducted at a University is, or should be, to teach the student how to think. We can imagine a student being passed through a series of experiments where all he had to do was to read certain instructions, pull certain switches, and record what was marked on certain instruments at stated intervals. He might have to do exactly similar work in actual practice afterwards, and he could possibly earn his living at it. He may have covered much ground, have stored his mind with facts, have learned carefully and well the methods of manipulating certain machinery. On the other hand, we can imagine another student, working away in a place where he had to exercise great ingenuity in order to devise apparatus for making his tests, acquiring principles and knowing the reason why of everything; perhaps not altogether familiar with the stop-valve of a large engine, and ignorant of what is inside the enclosed casing of the working parts, but very familiar with the principles upon which every heat engine must work and which make for economy. If we watch the two after graduation, we shall see that at the end of ten years the man whose education was built up upon the bedrock of elementary principles has distanced the one who started to build the structure with no foundation. The Universities should surely teach the student how to learn, and let his practical experience come later. If they have done their duty, the laboratories have given the student a trained mind, and it is his own fault if he does not broaden it with practical experience afterwards. We do not wish to make a machine of the student, or to pump into him a lot of information about practical work which will make him "too big for his shoes," when in the natural order of things he must take a subordinate position in industrial work after leaving college. In the multiplicity of experiments there is a danger of obscuring fundamental laws and principles, and students working with large apparatus and laboratories running with clock-work regularity do not perform experiments in a fashion that gives them education in self-reliance, in methods of ingenuity and in the ways of thinking. We must lead out from the student's mind, cultivate in the student's mind, the ability to reason, to scheme and to plan for himself. Especially in overcrowded laboratories we find students being drilled through their hours of instruction like performing animals put through tricks. Figures must be jotted down on printed laboratory forms; let but the apparatus be at fault and the student must be switched on to another experiment so that no time may be lost, and the apparatus is repaired by the staff when the students are not there. The bitterness of attempting to arouse enthusiasm and interest in any testing work in the man who knows nothing of electrical physics must have been felt by every laboratory instructor. Surely we can never hope to turn out a complete engineer, and no one would think of asking a college graduate to immediately take up works organisation or full managerial responsibility any more than to make him chief engineer of a central station. An apprentice or a workman with a small firm is likely to get much more varied and useful experience than one who is but a unit in a huge works, and is perhaps placed on one routine job for years. So it is possible with small engines and dynamos to learn more in a laboratory than by spending the time upon testing large units. It is the curse of our age that we all want to get rich without working, and it is the misfortune of the students that most of them want to learn without thinking. Such a great deal depends upon the attitude with which a student approaches his work. There must be something sacred in all knowledge, something for us to revere in the smallest laws of nature. It is for this reason that it would be well if the Press, and especially the daily Press, for reasons stated above, should teach the coming generation to enter the portals and temples of learning with due humility and respect. Not so long ago there was the cry sent up that as a nation we were being beaten both in ship-building and machine-tool making, but the answer to these prophets has come with the launching of the new Cunarders, and the building of the magnificent lathes for the rotors of the turbines which will propel them. There is a great work yet for the Press to do in educating the public. "The ordinary run of men live among phenomenon for which they care nothing, and know less. They see bodies fall to the earth, they hear sounds, they kindle fires, they see the heavens roll above them, but of the causes and of the inner working of the whole they are ignorant, and with their ignorance they are content." It is one of the most encouraging signs of the times for those who believe in the future of our race, that these things may, in a few decades hence, not be so.

Statesmen are demanding that the principles of science shall in future be taught in our Board Schools, and the ladder from the Board School to the University is yearly being made easier to climb. Our Universities require more funds and greater endowments, but on the whole, they are maintained with great efficiency. It is doubtful if any other institutions could furnish such examples of great self-sacrifice on the part of those who spend their lives in giving instruction without any great hope of monetary reward, and of hours of weary toil, cheerfully given, in the hope of probing yet deeper into nature's secrets, and so advancing the civilising influences which shall improve the lives and thoughts of mankind.

SOME CONSIDERATIONS ON THE DOUBLE-FLOW TURBINE.

[COMMUNICATED.]

To the general engineer the double-flow turbine is comparatively unfamiliar. This type of machine, however, is by no means obsolete; in fact, latterly it has made considerable progress. At least one prominent firm is successfully manufacturing a modification of the original Parsons double-flow turbine, which, in the writer's estimation, compares advantageously (from a purely mechanical standpoint) with any other type. A few remarks on the design and operation of such machines, therefore, may perhaps prove to be of interest.

The double-flow turbine, to stand its ground as a sound commercial commodity, must, in the first place, not be of abnormal length, or take up excessive floor space. This is an important feature, and the writer has in mind a machine built somewhat on the lines of a combination of the De Laval and Parsons types. By first passing the steam through one or two rows of impulse blades and afterwards completing the expansion through a series of low-pressure Parsons blades, a moderate speed can be obtained, while at the same time the total length is kept within reasonable and (when compared with the single-flow reaction turbine) advantageous limits.

There are undoubtedly some disadvantages inherent to the double-flow turbine, and these will be dealt with later.

Probably the most important advantage possessed by the double-flow type is the almost entire elimination of end thrust, and a consequent absence of all dummy pistons, equalising pipes &c. Although our manufacturers have now brought the mechanical construction of these parts to something approaching perfection, they are yet the cause of a direct steam loss (through leakage), and also help to increase the number of fine adjustments and clearances, and thus decrease the elements of simplicity in the machine.

The double-flow turbine possesses characteristics which adapt themselves to a simplicity in design unattainable with the single-flow turbine. Thus the comparative shortness of the turbine cylinder enables the turbine bearings to be set at a minimum distance apart. Again, as steam enters the cylinder at the centre, the overload or by-pass valve can be situated in direct line with the poppet valve, a point of some importance when the by-pass valve is operated by the relay plunger.

To ensure a sufficient stiffness and a correct distribution of metal in a turbine cylinder is no easy matter. These cylinders are often subjected to very severe strains (such as those occasioned when suddenly changing from vacuum to

atmospheric running), and here, again, the short cylinder of this type of double-flow machine possesses advantages over the long single-flow cylinder.

The writer, in conversation with an intelligent shift engineer who had had experience of both single and double-flow turbines, was informed by him that the double-flow was the preferable machine, because it necessitated no periodical feeling in the vicinity of the dummy rings to find out if they were running hot, and because it took only about half the time to warm up. Probably the latter statement is true, owing to the warming steam having to pass through clearances, equalising pipes, &c., before reaching the extreme high pressure end of a single-flow turbine of the reaction type.

There are circumstances under which a considerable and often serious end thrust may suddenly be thrown upon the spindle of a double-flow turbine. Suppose, for instance, that a strip involving several rows of blades occurred on one side only of the inlet. The result would very often prove disastrous, the inequality of pressure set up being probably sufficient to damage the comparatively weak thrust block to such an extent as to cause further mishap.

It may here be stated that a double-flow turbine is very seldom fitted with a thrust block of sufficient size to withstand very heavy thrusts. Its function is simply to take care of slight inequalities in pressure between the two ends of the machine, and to prevent the spindle from making any longitudinal movement under such conditions.

The two exhausts from a double-flow turbine should always, wherever possible, be connected by means of a breeches pipe, the single end of which leads to the condenser. If it be found impossible to use a breeches pipe, and the exhausts from the turbine are led into the condenser separately, it is, of course, necessary to place a valve in each of these exhaust pipes, as, when the turbine is exhausting into the atmosphere, it is desirable to cut off all communication with the condenser.

The writer witnessed a disastrous occurrence at a large power station in this connection, which, although caused through faulty operation, yet serves to point out a weakness.

The plant referred to consisted of a large double-flow turbo-generator set, the turbine exhausting into a large vertical surface condenser, by means of two separate exhaust pipes, with a valve on each pipe. Owing to the motor driving the circulating water pump burning out, the vacuum commenced to fall. Seeing this, an attendant at once shut both turbine exhaust valves, which were geared together by means of a chain and sprocket wheels to ensure simultaneous opening and shutting. Before the valves were quite closed it was found that the vacuum had fallen to zero at one end of the turbine, while 20 in. still remained at the other end. This state of things was occasioned by the lap on one valve being greater than that on the other. The speed being high, and the diameter of the spindle at the ends large, a very considerable end thrust was set up. The rings in the thrust block were partially sheared off, and about 17 rows of blades completely stripped out. The steam glands were also badly damaged. An experience of this kind served to show the absolute necessity of putting in a large equalising pipe between the two exhaust pipes below the turbine. This was at once done, and as a consequence no further trouble was experienced.

The foregoing incident does not disclose any inherent weakness in the double-flow turbine itself, but serves to show that special care should be exercised in the design of auxiliary plant for such machines.

It must be borne in mind that the type of double-flow turbine here described and advocated (from a mechanical view) is to be essentially a comparatively short machine. The writer wishes to emphasise this, because, unless that feature be strictly adhered to, the machine at once loses many of its most valuable advantages.

With the special form of construction hinted at earlier, the retention of the Parsons form of blading, together with the advantages accruing from stability, limited floor space, moderate speed, &c., this type of turbine (assuming the steam consumption to be satisfactory) certainly possesses qualifications which need little advertising.

All the previous considerations are, however, only of secondary importance to that of steam consumption, which, after all, is the most important factor in determining the relative merits of different types.

Can, then, a turbine possessing the undoubted advantages of such a machine as that described be made to compare favourably in steam consumption with, say, a modern single-flow Parsons machine? It would be unwise to say that this is beyond attainment, but up to the present those makers who have diverged into the manufacture of such "hybrid" types, have apparently not obtained results in steam consumption which could justify a universal adoption of those types.

It is hoped that the preceding impartial remarks about a type of turbine not very largely used up to the present, but undoubtedly having many prepossessing qualities, may prove of some value to the rapidly increasing number of persons becoming interested in this kind of prime mover.

REVIEWS.

Working Hints for Suction Gas Producers. By A. Flurscheim. London: *The Gas and Oil Engine Record.* 1906. Price 1s. net.

Though the suction gas producer may almost be said to be still in its infancy, it has found such great favour that it is being adopted with very great rapidity. This is due to its very high efficiency as an economical power gas producer, its extreme simplicity, compactness, cleanliness, and other qualities; and its manufacture has been undertaken by a very large number of different firms, both in this country and on the Continent.

Though it is a very simple apparatus, readily understood by workmen of average intelligence, there are certain points that should be common knowledge with those who are put in charge of even the smallest installation. The small work by Mr. Flurscheim clearly explains the various details to be taken into account to ensure the highest efficiency, satisfactory working, and also the safety of the man in charge.

In the 40 pages the author describes the details of a suction gas producer first generally, and later in more minute detail.

As might be expected, a typical producer having the greatest number of parts and accessories has been selected, to enable the different items and their uses to be described, but there are numerous installations which dispense with a considerable number of the non-essential accessories.

The aim of the power gas engineer is to design an efficient apparatus having the minimum number of parts, valves, gauges, &c., so that besides reducing the first cost, the attendant is relieved from having to bear in mind a number of valves to be opened or closed at the commencement or termination of the working period.

Though it might not appear from a perusal of the "Working Hints" that plants can be so designed as to require attention only two or three times a day, this is the case, and some producers are *locked up* during the greater part of the working period.

The author describes a "Pressure Gauge Board," but in actual practice most plants do not require this refinement, for as a general rule such apparatus is a superfluity, and usually out of order.

Though in the suction system there is no leakage of poisonous gas into the surrounding atmosphere during the time that the engine is in operation, there are certain precautions necessary at such times as the cleaning of the producer and the changing of the materials in the scrubber employed for purifying the gas, such as coke, or planks placed edgewise, &c., so that the instructions given by the author should be carefully adhered to.

Besides the danger from inhaling the gas, it sometimes happens that when the fire is being withdrawn, the gas in the upper part of the producer becomes ignited and a considerable volume of flame issues suddenly through the cleaning door; unless this is anticipated, it may result in a more or less serious accident, by burning, to the attendant.

The work is illustrated by diagrammatic drawings of the Pintsch Suction Gas Producer, with its numerous accessories and refinements, and the "Acme" Suction Gas Installation of much simpler form. If all the "Working Hints" given by Mr. Flurscheim are borne in mind, any suction plant should be run satisfactorily and without false starts; for the neglect to close a test-cock may easily cause an otherwise satisfactory start to result in a considerable delay through air being drawn in, and so diluting the gas as to bring the engine to a standstill.

The Electrical Nature of Matter and Radio-Activity. By Prof. Harry C. Jones, Johns Hopkins University. London: A. Constable & Co. Price 7s. 6d. net.

This well printed little work consists of about 200 pages, and is divided into 18 chapters.

These deal in non-mathematical language with such things as the electrical conductivity of gases, determination of the mass of the negative ion, X-rays, radium, α, β, and γ-rays, and the production of heat by radium salts, &c.

The work is based on a series of articles which recently appeared in the *Electrical Review*, of New York, and is very clearly written, references being given to original papers, &c., where necessary.

There are about seven chapters in which the emanation from radio-active substances, induced radio-activity, and the production of radio-active matter are discussed, as well as the more recent work on these subjects.

On page 4 the explanation of the Crookes paddle-wheel experiment might be modified in accordance with the more generally accepted view. Advanced students might also refer to a recent paper by J. J. Thomson on the number of electrons in an atom (*Phil. Mag.*, July).

The aim of the author, as stated in the preface, has been to "present the more important facts and conclusions on the Electrical Nature of Matter and Radio-Activity, as far as possible in non-mathematical language."

The author is to be congratulated on producing a very readable book, which will be appreciated by many, especially those commencing the study of the subject.

The Corrosion and Protection of Metals, with Special Reference to the Preservation of Engineering Structures: By Prof. A. Humboldt Sexton. Manchester: The Scientific Publishing Co. Price 5s. net.

It is one of the functions of the engineer to be responsible for much earthly treasure under circumstances where rust doth corrupt, and where the enemies corrosion and disintegration steal away its utility. Therefore, such books as this of Prof. Sexton's are of value and interest. As the author points out, the distinctive literature on the subject is scanty, although much may be learnt from searches into more encylopædic volumes dealing with numerous other subjects. There is in general a deplorable disregard of, and in difference to, this subject, and but little analytical research upon it has been carried out. Such research costs money, and only too many engineering firms prefer to expend money on more paint, or ultimately on new structures, rather than on the preliminary experimenting, which is cheaper in the long run. Many will urge that laboratory experiment and the conditions arising in actual practice are by no means interchangeable. This we grant; nevertheless, it is only in the artificial, but more arduous, conditions of the laboratory that obscure and insidious causes of trouble can be investigated with an exactitude which is beyond question. Climatic conditions are all-important, and the reviewer doubts whether such a structure as the iron column of Delhi would have long withstood the carbonic acid gas-laden atmosphere of an English manufacturing town.

In discussing different preservatives the author points to the defect possessed by tin, which is readily attacked by corroding agents, and "being electro-negative to iron, once the surface is broken through electric [should this not be electrolytic?] action is set up, which greatly accelerates the corrosion of iron. Zinc, on the other hand, although more readily attacked by acids and alkalies, resists atmospheric corrosion very well."

The notes on oils and their functions are very clearly written, and purity and good quality and insisted upon. As regards repainting, emphasis is naturally laid upon the necessity for cleaning and drying the surface before applying even a good paint. Otherwise it seems a fair inference that if the repainting is to be done on a badly-prepared surface, a bad paint would not make the ultimate result worse. Perhaps even a low-grade paint well applied might be preferable to a high-class paint badly used.

Passing to other metals than iron and steel, Chapter III is devoted to notes on the atmospheric corrosion of lead, zinc, copper, tin, aluminium, nickel and alloys.

Chapter IV deals with the corrosion of metals by corrosive gases, tunnels and boiler flues being the occasions where such difficulties arise.

Other chapters deal with corrosion in liquids, such as sea water, particular attention being given to the alloys used for condenser tubes.

Some Founders of the Chemical Industry: Men to be Remembered. By Frederick Allen. London and Manchester: Sherratt & Hughes. 1906. Price 5s. net.

These papers, which deal with the origins and industrial lives of eight well-known heads or important members of firms in the Lancashire and Tyne districts, were first published in the *Chemical Trade Journal* at the instance of its proprietor and editor, Mr. Geo. E. Davis. They have been published in the present book form without alteration, which perhaps accounts for a few inaccuracies in names and dates that we notice.

Although we have some prejudice, probably the result of early training, against what may be termed Smilesian biography—lives of the money-getters—we have been, on the whole, agreeably disappointed in reading Mr. Allen's book, though he has been so unkind as to preserve some specimens of what he, and the late Mr. Peter Spence, consider "poetry," produced by the latter.

The selection of the names has been made in a somewhat peculiar manner, for while some, such as Wm. Gossage, A. Kurtz, Henry Deacon, and, in a lesser degree, P. Spence, were remarkable as practical men, chemists and inventors, and even, as in Deacon's case, real men of science, the others, Muspratt, Gamble, Shanks, and particularly C. Allhusen, were business men, shrewd managers, or financial experts.

All these men, except Deacon, were born during the tremendous cataclysm of the end of the eighteenth and the beginning of the nineteenth century, and we owe Kurtz and Allhusen directly to the Napoleonic invasions of Germany and Denmark, which drove them from the places of their birth.

The notices of Gossage and Kurtz are peculiarly interesting, as especially in the former we get glimpses of the thoughts that were moving three-quarters of a century ago, and see that a number of inventions only recently brought successfully into use were existing in embryo even then. Indeed, it is not too much to say that Gossage went so far that a rigid interpretation of our patent laws would have invalidated such important patents as those of Weldon, as to manganese recovery, and of Mond and Chance as to sulphur recovery, on the ground of prior disclosure of the essentials by Gossage in 1837.

The lesson to be drawn from the work of the really pioneer minds such as those of Gossage and Deacon is the enormous difficulty encountered in the pushing forward of practical manufactures beyond the boundaries laid down by the general knowledge of the time, and still more by those due to the imperfections of engineering methods and materials. The story of the discovery of the ammonia soda process by Hemming and Dyer, and of its actual working in Whitechapel about 1838 is, of course, well known, but what is not so well known is that Deacon made a tremendous struggle to carry out a similar process, and about 1854 had, as he always declared, nearly succeeded, when his partners, first William Pilkington, and next H. Gaskell, refused to find any more capital, and insisted on the abandonment of the work. Thus, Deacon suffered from the timidity of capital, but the writer of this review saw him also subjected to the gibes of the Academic scientist, as was the case when, in June, 1872, he read his paper at the

Chemical Society's Rooms "On Deacon's Method of obtaining Chlorine as Illustrating some Principles of Chemical Dynamics."

Truly the way of the industrial scientific man is hard, and we cannot grudge the modest fame which such books as Mr. Allen's endeavour to confer on some of the more successful, although, as we have before remarked, Smilesian biography is not much to our taste.

ELECTRICITY AND MINING OPERATIONS.

Two articles in successive numbers of the *Engineering Magazine*, by Mr. Charles V. Allen, treat respectively of the abstract proposition of "Mining and Milling by Electro Power Machinery," and the concrete example, "Electric Machinery for the Operation of Mexican Mines." Both are well written, the abstract proposition setting out the general advantages offered by electric driving to the mining industry. The need for mine pumping—a factor which tended materially to expedite the early evolution of the steam engine—affords now a field in which better results can be obtained where fuel is expensive by motor-driven pumps. Neither a central battery of boilers with steam pipes radiating long distances to isolated steam engines, nor smaller groups of boilers scattered over a mining area, can be considered to be thermally or economically satisfactory. In a contest between the steam pipe and electric cable all theoretical and practical economy is on the side of the more flexible and easily fitted cable. Next to pumping, haulage may be mentioned, either along headings or up shafts. In regard to the latter, Mr. Allen cites in his first article a case where electric hoisting has been substituted for steam. "The electric hoist elevated the cage at 1,250 ft. per minute, raising 500 tons daily from a 2,500-ft. level by double-deck cages carrying 3,600 lb. of ore. Up to the time electricity was adopted, the cost of motive power was never less than $20.00 per H.P. per month; after that it cost $7.00 per H.P. per month." If the price of fuel per ton and of electrical energy per unit had been stated, the value of these figures would have been increased.

Another feature is in the use of centrifugal pumps for sinking purposes where the work is exceedingly severe, and the head continually increases with the depth of the shaft. For this work the motors are designed for a fixed head, and for low lifts this is artificially produced by throttling the delivery.

The electric drill, driven by small alternating-current motors, is regarded as not perfect. Compressed-air drills are more effective for gold-bearing quartz, but electricity comes in with marked advantage over steam for driving the air compressors. A steam-driven air-compressor should be near the boiler from which its steam is obtained, but the conveyance of compressed air over long distances by piping is itself costly. Mr. Allen states: "An installation of an electric motor in a Californian mine, to take the place of steam-power in driving a 100-H.P. air compressor, resulted in reducing the cost of operation from an average of $1,800 per month to $672."

On the question of polyphase alternating as against direct-current installations, the author favours the former with a motor-generator for supplying direct current to locomotives. For all-round duties, such as driving fans, blowers, compressors, stamp battery shafts, tube mills, &c., the squirrel-cage induction motor, with its auto-starter, is recommended; and for machines of 100 or 200 H.P. or over (depending upon the magnitude of the power station), synchronous motors, started by small induction motors on the shaft. Both generators and motors, in such a case, should be fitted with damping coils to eliminate speed fluctuations and field distortion. For battery stamps, 50-H.P. motors should be used to operate groups of 20 stamps each, while for tube mills for crushing the ore, induction motors and heavy fly-wheels on the crushers are necessary.

The concrete example deals entirely with the El Oro mining region, to which reference has already been made in these pages. The introductory remarks are geological, and these we can entirely omit, together with the history of the mine itself, quoting *in extenso* certain of the author's paragraphs.

"In consideration of the large amount of power used in the El Oro camp and vicinity, all being developed by steam, with wood costing from $3.50 to $4.50 per cord and American coal $11.00 per ton, United States currency, the Mexican Light and Power Co. decided to extend their transmission (already operating from Necaxa to Mexico City) 90 miles farther to El Oro, their circuit thus forming an obtuse angle, with Mexico City at the apex. They contracted with the three largest consumers, the El Oro Mining and Railway Co., the Esperanza Co., and Dos Estrellas, for approximately 10,000 H.P.

"The source of electric power for the entire El Oro district is 171 miles distant, near Necaxa, in the State of Puebla, where the Mexican Power and Light Co. have their main generating station, 100 miles north-west of Mexico City. Near Necaxa the Tenango River unites with the Necaxa River, giving a minimum flow in the dry season of 1 cb. metre a second, with a maximum of 90 cb. metres. The river drops 3,000 ft. in about three miles, on its way to the Gulf of Mexico. The first plant, now being installed, will utilise two falls, making a total of 1,300 ft. head, or about 40,000 E.H.P. A second fall of 1,300 ft. is available down stream, for the further development of 40,000 H.P. more when needed. The water-wheels used are capable of developing 8,200 H.P. each, and there will be six 5,000-KW., direct connected, vertical shaft, alternating-current generators, revolving field type, three-phase, 4,000 volts, 50 cycles, making 300 revolutions. This voltage is raised by transformers to 60,000 volts, and the energy transmitted about 96 miles to Mexico City, over four three-phase circuits comprising twelve 168,000 circular mils stranded copper cables, each of which corresponds to about No. 000 B. & S. wire.

"These cables are carried on two steel tower lines, two circuits to a line. A similar single-tower line with two circuits transmits a part of the energy from Mexico City to El Oro, a distance of 75 miles. In El Oro at the sub-station, which is equipped with lightning arresters, transformers and switchboard, the voltage is reduced to 3,000 volts before distributing to the various mining and milling customers, the most distant of which is about 6 miles. There are seven 1,800-KW. transformers installed in this sub-station."

The entire electrical equipment, amounting to some 4,000 H.P., was supplied by the Westinghouse Electric and Manufacturing Co., of Pittsburg.

"All the motors employed are three-phase 50-cycle (6,000 alternations), and, as a rule, are 400-volt induction type for 200 H.P. and less, and 3,000-volt synchronous above 200 H.P.

"A separate sub-station has been provided by the El Oro Co. to receive the current from the power company, and distribute it to the various mills and mine shafts. Here the power is measured by the power company with integrating wattmeters, and passed to the seven-panel Vermont marble distributing switchboard, each panel of which contains the usual instruments and switches.

"As the new mill in which electric driving has been introduced had been originally ordered with provision for steam drive, before the possibility of electricity coming into the camp was known, it was thought best after contracting for the electric power to keep the engines as far as possible so that they could be placed in service quickly should there be any failure in the power service due to lightning or line disturbances. For this reason the 550-H.P., 88 revolutions, two-bearing synchronous motor driving the entire 100 stamps and three tube mills, and the 260-H.P., 88 revolutions, two-bearing synchronous motor driving the cyanide plant, were installed in a very ingenious manner. The motors were constructed with shafts extended on both ends to receive half-couplings, the motors being installed between engines and shafts to be driven, with all shafts in each set in line. A flexible coupling of rubber cylinder type connects motor and driven shaft, and a special semi-flexible form of key-plate coupling connects motor and engine shaft. Normally, the bolts and the middle or key section of the latter couplings are left out when the motors are driving. In 15 minutes or less, these can be put in place, thus allowing the engines to drive the shafts, revolving the rotors of the motors at the same time. It has never yet been found necessary to resort to this expedient.

"The auxiliary drives in the cyanide plant, which were operated from the shaft now driven by the 260-H.P. motor, were originally made by means of long wire rope drives, some through intermediate counter shafts carrying the power a considerable distance. Later, individual motor drives on the cyanide machinery have been installed in several places, avoiding long transmissions and cheapening operation. It is true this obviates the possibility of driving the cyanide plant from the 260-H.P. engine. To off-set this, the 260-H.P. synchronous motor which is connected to the engine will be driven as a generator, should it ever be necessary, feeding back through its own panel to the main distributing switchboard, whence the current can be distributed to the motors in whatever part of the mill or mine is without steam.

"In the new engine room are to be found a 150-KW. direct-current, 125-volt lighting generator coupled to an Ideal engine, a part of the original steam equipment. As new apparatus, there is a 150-KW. 580-revolution direct-current compound-wound 125-volt lighting motor-generator set, for lighting the entire plant and town of El Oro, driven by a 200-H.P. alternating-current motor, duplicating the above, and two 50-KW. 720-revolution direct-current, compound wound, 125-volt motor-generator sets driven by 75-H.P. alternating-current motors, each of which latter has a capacity of exciting the fields of all of the synchronous motors about the plant. These motor-generator sets are self-contained, each with a common base and shaft supported by two bearings. The switchboard for controlling all of the machines in this engine room is built of blue Vermont marble, and comprises eight panels with all the necessary instruments.

"The auto-starter employed to start the 200-H.P. motor and the other large induction motors about the plant, is of the multi-point, oil-immersed drum type, and being a recent development by the Westinghouse Co., is worth a brief description. This type of starting device is used with constant-speed induction motors, 75 H.P. and over. It is bolted to the floor over a 16-in. hole cut in the same. The oil tank is bolted to the controller frame with two side bolts, and is raised and lowered by means of a central-threaded screw rod. The same handle that operates the controller, raises and lowers the oil tank by changing a nut at the top of the handle. The tank can be lowered below the floor 2 ft., which exposes all connections and contacts for inspection and repair. In operation the motion of the handle is always to the right, whether starting or passing from running to off. From six to nine different voltages are applied to the motor from off to full-on position, depending on the horse-power capacity of the motor operated, thereby keeping down the peak, which would otherwise result from the throw of an ordinary double-throw starting switch.

"Several large electric centrifugal pumps for handling water are in use, requiring motors up to 130 H.P. capacity. One 130-H.P. motor drives a Gould's station mine pump in the incline shaft,

handling 500 gallons of water per minute against a head of 800 ft.

"The machine and framing shop each take a 40-H.P. motor, and other motors are located in the assay office, blacksmith shop, &c. A 150-H.P. synchronous motor by belting drives a 12-drill air compressor, and a 200-H.P. 166-revolution direct connected synchronous motor air compressor is contemplated shortly. Two of these latter outfits are now in operation at the Dos Estrellas mines near by.

"At the North shaft, which is used principally for raising and lowering men and timber, there is installed a 120-H.P. variable speed induction motor coupled direct to the pinion shaft of the hoist, the speed at full load being 194 revolutions. Although in addition to the motor the original mechanical brake is used, for further safety an ingenious device is used in employing the old steam cylinders of the hoist. In lowering a cage down the shaft the pistons are made to compress air in the cylinders, so that by opening or closing a valve connected thereto very fine speed regulation can be obtained."

A further article from the same pen is promised in a succeeding issue to complete the description of the installation at El Oro, and especially the hoisting outfit at the Somera shaft.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

21,111. "System of regeneratively controlling electrically-propelled vehicles or other installations of electromotors." S. T. Webster. September 24th.

21,129. "Improved means of ventilating the dynamo and motor of petrol electric automobiles." W. A. Stevens. September 24th.

21,146. "Improvements in controllers for electric elevators and the like." K. R. Odman. (Date applied for under Patents Act, 1901, March 1st, 1906, being date of application in Sweden.) September 24th. (Complete.)

21,159. "Improvements in methods of the regulation of single-phase dynamo-electric machines of the commutator type." Allgemeine Elektricitats Gesellschaft. (Date applied for under Patents Act, 1901, September 25th, 1905, being date of application in Germany.) September 24th. (Complete.)

21,167. "Improvements in junction boxes for electric cables." W. T. Henley's Telegraph Works Co., Ltd., and W. H. Nichols. September 24th.

21,206. "Improvements in electrical time switches." R. F. S. Venner and R. C. Griesbach. September 25th.

21,208. "Improvements in the apparatus for electrical spark gaps." H. E. Fry. September 25th.

21,218. "Improvements in the methods of operating electrically-driven tools and appliances performing a cycle of operations or working intermittently." P. H. Dawe. September 25th.

21,232. "Improvements in or relating to dynamo-electric machinery." Siemens Bros.' Dynamo Works, Ltd., and F. Lydall. September 25th. (Complete.)

21,252. "Improvement in or relating to accumulator boxes and other receptacles." J. Stone & Co., Ltd., and E. M. Preston. September 25th. (Complete.)

21,253. "Improvements in and relating to the control of electric motors more especially applicable in the operation of bulkhead doors and the like." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) September 25th.

21,273. "Improvements in dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) September 25th. (Complete.)

21,279. "Electric air-heaters for heating and ventilation systems, and for analogous purposes." T. E. Weaver. September 26th.

21,288. "Improvements in electric batteries." F. Richmond. September 25th.

21,290. "Novel or improved insulating composition for use as a filling material within troughs and other conduits, containing electric cables." J. Johnson and J. Titley. September 26th.

21,299. "Electrical fire-guard." J. Robinson and H. Walker. September 26th.

21,308. "Improved fire-preventing device for use upon electric installations for lighting, heating and like purposes." S. R. Evans. September 26th. (Complete.)

21,338. "Improvements in the application of the electric arc for producing reactions in a gaseous mass, and in apparatus therefor." A. A. Naville, P. A. Guye and C. E. Guye. September 26th.

21,348. "Improvements relating to galvanic cells." H. P. R. L. Porscke. September 26th. (Complete.)

21,349. "Improvements in the electrolytic production of copper wire, strip or the like." S. O. Cowper-Coles. September 26th.

21,390. "Improvements in combination switch and wall connections." A. P. Lundberg, G. C. Lundberg and P. A. Lundberg. September 27th.

21,391. "Improvements in wall connections and the like for electric lighting, heating and power purposes." A. P. Lundberg, G. C. Lundberg and P. A. Lundberg. September 27th.

21,416. "Improvements in and relating to electrical furnaces." F. A. Kjellin. (Date applied for under Patents Act, 1901, March 5th, 1906, being date of application in Sweden.) September 27th. (Complete.)

21,435. "New or improved automatic electric safety alarm." A. W. Empson. September 27th.

21,468. "Improvements in clamps for attaching anchor wires or strain wires to electric trolley wires in the construction of anchor ears for trolley wires." C. Mittelhausen and B. Munro & Rogers, Ltd. September 28th.

21,472. "Improvements in electric batteries." H. W. van Raden and C. B. Robinson. September 28th. (Complete.)

21,495. "Improvements in and relating to electro-magnetically operated valves." E. L. White and E. C. Hoegerstaedt. September 28th.

21,504 "Improvements in and in the manufacture of electric conductors of refractory metal, applicable more especially for use as incandescing bodies in electric lamps or other apparatus." The British Thomson-Houston Co., Ltd. (General Electric Co., United States.) September 28th.

21,505. "Improvements in and in the manufacture of electric conductors of refractory metal, applicable more especially for use as incandescing bodies in electric lamps and other apparatus." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) September 28th.

21,506. "Improvements in and relating to joints between electric conductors, especially applicable to joints for electric incandescent lamp conductors." The British Thomson-Houston Co., Ltd. (General Electric Co., United States.) September 28th.

21,508. "Improvements in and in the manufacture of electric conductors of refractory metal." The British Thomson-Houston Co., Ltd. (General Electric Co., United States.) September 28th.

21,509. "Improvements in and in the manufacture of electric conductors of refractory metals." The British Thomson-Houston Co., Ltd. (General Electric Co., United States.) September 28th.

21,510. "Improvements in electrodes for electric arc lamps and the like and in the methods of making the same." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) September 28th.

21,511. "Improvements in and in the manufacture of electric conductors of refractory metal." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) September 28th.

21,512. "Improvements in and in the manufacture of electric conductors of refractory metal applicable more especially for use as incandescing bodies in electric lamps and other apparatus." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) September 28th.

21,513. "Improvements in and in the manufacture of electric conductors of refractory metal and in apparatus therefor." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) September 28th.

21,518. "Improvements in electrical measuring instruments, automatic cut-outs and the like." H. Chapma September 29th.

21,523. "Automatic electric fuse." C. B. Bathgate and T. Bellis. September 29th.

21,524. "Improvements in or relating to the circuit-closing attachments of electric resistances." J. A. Kennedy-McGregor. September 29th.

21,543. "Improvements in electrical speed and distance indicators for wheeled vehicles." E. I. Everett and K. Edgcumbe. September 29th.

21,546. "Improvement in electric switches." H. Hirst and H. T. Harrison. September 29th.

21,578. "Improvements in and relating to the manufacture of incandescing lamp filaments." R. Jahoda and Electrische Gluhlampenfabrik "Watt" Scharf, Lofi & Latzko. September 29th.

21,580. "Cord grip for suspending electric incandescent mps and the like." J. Jessel. September 29th. (Complete.)

21,583. "Improvements in the electrolytic manufacture of metallic wire, strip or the like." S. O. Cowper-Coles. September 29th.

21,585. "Improved manufacture of electrical contracts consisting of mixtures of metal and carbon." Gebruder Siemens & Co. (Date applied for under Patents Act, 1901, September 30th, 1905, being date of application in Germany.) September 29th. (Complete.)

21,586. "Electro-magnetically operated mechanism for reversing the motion of machine tools, with to and fro moving table." J. Billeter. September 29th. (Complete.)

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1905.

High Tension Magneto-Ignition Systems. G. N. Smith. (A. P. L. Boulanger, France.) 22,862. November 7th.

Shade Holders for Incandescent Electric Lamps. H. Simmonds. 23,728. November 17th.

Means for Controlling Self-Exciting Dynamo-Electric Generators. The British Thomson-Houston Co. (General Electric Co.) 24,024. November 21st.

Vapour-Electric Apparatus. The British Thomson-Houston Co. (General Electric Co.) 24,025. November 21st.

Electric Controllers. C. W. Atkinson. 24,729. November 29th.

Electric Transformer Furnaces. O. Frick. 25,771. December 11th.

Electric Clocks. C. Hubert. 26,046. December 14th.

1906.

Dynamo-Electric Generators. Elektrizitäts-Akt. Ges. vorm. W. Lahmeyer and Co. (Date applied for under International Convention, April 28th, 1905.) 8,785. April 11th.

Electric Gas Igniter for Street Lamps, and the like. G. Lentschat and W. J. Drahonowsky. 8,792. April 11th.

Rotating Field Magnets of Electric Machines. Siemens Bros. & Co. (Siemens Schuckertwerke Ges.) 9,488. April 23rd.

Electric Motor Mechanism for Automobiles. A. Weiss. (Date applied for under International Convention, January 16th, 1906.) 9,904. April 27th.

Electric Cut-Out and Distribution Box. G. Scoccimarro. 13,885. June 18th.

Suspension of Arc Lamps, or the like. C. A. Schaefer. (Date applied for under International Convention, November 28th, 1905.) 15,007. July 2nd.

Electricity Meters. O. T. Blathy. 1,487. January 19th.

Electric Controller for Lifts, Hoists and Cranes. J. Mair. 2,185. January 29th.

Manufacture of Filaments for Electric Incandescent Lamps. H. Zerning. 2,554. February 1st.

Regulation of Alternating-Current Circuits Subject to Fluctuations of Load. Siemens Bros. & Co. (Siemens Schuckertwerke Ges.) 3,677. February 14th.

Telephonic and Similar Instruments. W. D. Shaw-Browne and S. A. Williams. 5,093. March 2nd.

Magnets for Alternating Currents. The Elektricitäts Act.-Ges. vorm. W. Lahmeyer & Co. 5,1o4. March 2nd. (Date applied for under International Convention, May 31st, 1905.)

Electric Circuit Closing Devices. W. G. Collins. 6,155. March 14th.

Arc Light Carbons. A. Kufferath and the firm of Dr. L. C. Marquart. 6,515. March 17th.

Processes for the Production of Voltaic Strong Current Arcs. H. Pauling. 7,869. April 2nd.

Manufacture of Incandescence Bodies for Electric Lighting. O. Imray. (Siemens & Halske Akt.-Ges.) 8,840. April 12th.

Electric Switches. Allgemeine Elektricitäts-Ges. 12,855. June 2nd. (Date applied for under International Convention, June 5th, 1905.)

Use of a Special Active Material for Manufacturing Accumulators. C. Jeantaud. 52. January 1st. (Date applied for under International Convention, January 5th, 1905.)

Electric Circuit Closers and Breakers. F. W. Howorth. (A. Winton, United States.) 152. January 2nd.

Electric Furnaces. G. Gin. 1,019. January 15th.

Electric Power Horizontal Log Band Saw Machines. A. Ransome and A. Lavo. 1,152. January 16th.

Process for Electrolytically Producing Persulphates. G. Teichner and P. Askenasy. 2,823. February 5th.

Manufacture of Insulating Material and Coating of Metal and other Surfaces Therewith J Connolly 3,345. February 10th